PHILIPPINE
JOURNAL
OF
SCIENCE

59
JAN-APR
1936

THE PHILIPPINE JOURNAL OF SCIENCE

VOLUME 59

JANUARY TO APRIL, 1936

WITH 89 PLATES AND 27 TEXT FIGURES

MANILA
BUREAU OF PRINTING
1936

300524

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, P. I., as second-class matter.]

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MANILA
BUREAU OF PRINTING
1936

297393

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, P. I., as second-class matter.]

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 59 JANUARY, 1936 No. 1

NEW OR NOTEWORTHY PHILIPPINE ORCHIDS, VI

By OAKES AMES

Professor of Botany, Harvard University

and

EDUARDO QUISUMBING

Curator, Philippine National Herbarium, Bureau of Science, Manila

NINE PLATES

The present paper is essentially similar to its predecessors.[1] It consists of descriptions of four new species. The genera *Bromheadia* and *Ascoglossum* are new to the Philippines. *Nephelaphyllum pulchrum* Blume and *Ascoglossum calopterum* (Reichb. f.) Schltr. are for the first time credited to the Philippines. Illustrations of two Philippine species, *Nephelaphyllum mindorense* Ames and *Plocoglottis lucbanensis* Ames, are also included.

All descriptions in the text have been prepared from living specimens, and all colored illustrations were made by Mr. Pedro Ramos, draftsman of the National Museum Division, Bureau of Science. All line drawings were prepared by Messrs. Marasigan, Aguilar, and Castelo, and Miss Ico, artists of the National Museum Division. All the types of the new species have been deposited in the Philippine National Herbarium, Bureau of Science, and the isotypes in the herbarium of the senior author. Available types will be distributed to American and European

[1] Philip. Journ. Sci. 44 (1931) 369–383, 16 pls.; 47 (1932) 197–220, 29 pls.; 49 (1932) 483–504, 28 pls.; 52 (1933) 443–473, 17 pls.; 56 (1935) 453–469, 10 pls.

herbaria. The color terms used are mostly from Ridgway's Color Standards and Color Nomenclature (1912).

Genus MALAXIS Solander ex Swartz

MALAXIS PURPUREIFLORA Ames and Quis. sp. nov. Plate 1, fig. 9; Plate 2, figs. 1 to 8; Plate 7.

Radices numerosae, fibrosae. Herba terrestris, prope basim foliosa, circiter 25 cm alta. Caulis brevis, crassus, 3.5 ad 5 cm longus, vaginis tubuliformibus inflatis membranaceis imbricantibus omnino obtectus. Folia 3 ad 8; lamina lanceolato-elliptica ad late elliptica, acuminata, acuta, 7 ad 20 cm longa, 2.5 ad 8 cm lata, nervosa, paulatim in petiolum latum basi dilatatum vaginantem transiens. Pedunculus gracilis, cum racemo 45 ad 46 cm longus. Bractei scariosae, triangulari-lanceolatae, acutae, 4 ad 6 mm longae. Flores juveniles approximati ut videtur, sed tardius remotiores. Sepala petalaque margine valde revoluta. Sepala lateralia suborbicularia, apice late rotundata, circiter 4 mm longa, 3.2 mm lata, 4- ad 5-nervia. Sepalum dorsale oblongo-ellipticum, obtusum, circiter 5.4 mm longum, 2.4 mm latum, 3- ad 5-nervium. Petala anguste oblongo-elliptica, obtusa, 4.75 ad 5 mm longa, 1.4 ad 1.7 mm lata, 3-nervia. Labellum in circuitu suborbiculare, valde auriculatum, circiter 6 mm longum, 5.5 ad 6 mm latum, antice acute pluridentatum cum callo semicirculari lobulato circa gynostemium ornatum, postice in auriculae triangulari-ovatas retrorsas obtusas extensum. Gynostemium per breve, bialatum. Anthera oblata. Pollinia 4, pyriformia, per paria cohaerentia.

Roots numerous, fibrous. Terrestrial herb, about 25 cm tall, leafy at the base. Stems short, stout, 3.5 to 5 cm long, concealed by the swollen, infundibuliform membranaceous leaf-sheaths. Leaves 3 to 8, with petioles imbricating below; lamina lanceolate-elliptic to very broadly elliptic, acuminate, acute, 7 to 20 cm long, 2.5 to 8 cm wide, 5-nerved. Peduncles slender, including the racemes 45 to 46 cm long, provided with triangular-lanceolate, acute, scarious bracts, 4 to 6 mm long. The buds and young flowers at the apex of the racemes crowded, older flowers remote. Sepals and petals with strongly revolute margins. Lateral sepals suborbicular, broadly rounded at the apex, about 4 mm long, 3.2 mm wide, 4- to 5-nerved. Dorsal sepal oblong-elliptic, obtuse, about 5.4 mm long, 2.4 mm wide, 3- to 5-nerved. Petals narrowly oblong-elliptic, obtuse, 4.75 to 5 mm long, 1.4 to 1.7 mm wide, 3-nerved. Labellum suborbicular in

outline, prominently auriculate, about 6 mm long, 5.5 to 6 mm wide, 8- to 10-dentate on the anterior margin, extended at base into a pair of retrorse triangular-ovate rounded auricles. Disc in front of the column, with a semicircular lobulate callus. Gynostemium very short, 2-winged. Pollinia 4, pyriform, in pairs.

LUZON, Benguet Subprovince, near Baguio, on rocks on the Naguilian Trail, *Phil. Nat. Herb. 79 Mrs. K. B. Day*, June 29, 1934.

The species is especially characterized by the purple color on the lower surface of the leaves, the purple flowers and the 8- to 10-sharp-toothed labellum. It differs from all its nearest allies—*M. atrosanguinea* Ames, *M. bulusanensis* Ames, and *M. Taylori* Ames—in its much broader petals and in the teeth on the anterior margin of the lip.

Genus NEPHELAPHYLLUM Blume

NEPHELAPHYLLUM MINDORENSE Ames. Plate 1, figs. 3 and 4; Plate 2, figs. 21 to 31; Plate 8.

Nephelaphyllum mindorense AMES in Philip. Journ. Sci. 2 (1907) Bot. 316, Orch. 3 (1908) 83, *t. 55*, 5 (1915) 48, in Merr. Enum. Philip. Fl. Pl. 1 (1924) 280.

"Closely allied to *N. pulchrum* Blume. Plants about 2 dm. tall. Rhizome creeping, slender, rooting at intervals. Stems purple. Leaves with the under surface uniformly dark purple, upper surface mottled, ovate-lanceolate, acuminate, acute, 8–10 cm. long, 3–5.5 cm. wide near the base. Petioles relatively slender, about 3 cm. long. Peduncles exceeding the leaves, clothed with several scarious, tubular, acute sheaths. Inflorescence loosely few-flowered. Bracts about 1 cm. long, linear, acute, scarious, somewhat shorter than the pedicels of the white flowers. Lateral sepals linear-acute, 1-nerved, 9 mm. long, 1.5 mm. wide. Upper sepal similar and equal to the laterals. Petals oblong, acute, slightly broader above than below the middle, 1-nerved, about 8 mm. long, 3 mm. wide. Labellum suborbicular, entire, 9–10 mm. long, 9–10 mm. wide, with 3 prominent converging lamellae near the apex, which pass basally into the main nerves of the hairy disc. Spur blunt, inflated, 4–5 mm. long."—AMES, loc. cit.

LUZON, Benguet Subprovince, Baguio, *Phil. Nat. Herb. 80 Mrs. K. B. Day*, June 29, 1934: Nueva Ecija Province, Mount Umingan, *Bur. Sci. 26319, 26494, 29652 Ramos and Edaño*, August and September, 1916. MINDORO, along Binabay River, *Merrill 5623* (type in Phil. Nat. Herb.), November 2, 1906.

The peduncles are purple; sepals and petals pale grass green flushed with light brownish olive and lined with purple-drab; labellum white except the lamellæ orange-chrome; anther orange

chrome. Terrestrial orchids on dry slopes and in humid forests at 200 to 1,700 meters altitude.

NEPHELAPHYLLUM PULCHRUM Blume.

Nephelaphyllum pulchrum BLUME Bijdr. (1825) 373, *f. 22*, Fl. Jav. Orch. (1858) 144, *t. 61, f. 1, t. 54 F;* LINDL. Gen. & Sp. Orch. (1830) 24; REICHB. F. Xenia Orch. 1 (1856) 216, *t. 88, f. 1;* MIQ. Fl. Ind. Bat. 3 (1859) 675; Bot. Mag. 88 (1862) *t. 5332;* HOOK. F. Fl. Br. Ind. 5 (1890) 818; J. J. SM. Fl. Buitenz. 6 (Orch. Java) (1905) 178, Fig.-Atlas (1909) *fig. 135;* SCHLTR. Die Orchideen (1927) 127.

The original description reads as follows:

"N: floribus dense spicatis, labelli limbo lineis tribus muricatis.
"*Crescit:* in locis humidioribus sylvarum Salak.
"*Floret:* Januario–Aprili."—BLUME.

Plants ascending, 10 to 15 cm high; rhizome creeping, slender, rooting at intervals. Leaves three in our plant, submembranaceous, ovate or triangular-ovate, subcordate at the base, acuminate-acute at apex, 8.4 to 9 cm long, 4 to 4.2 cm wide near the base, uniformly dark purple beneath, silvery green with dark green reticulations above; petioles 1.3 to 1.8 cm long. Inflorescence terminal, few-flowered; the peduncle clothed with several scarious tubular sheaths, erect, about 4 cm or more long. Flowers about 2.8 cm across. Sepals and petals reflexed. Sepals linear, acute, about 12.7 mm long, 1.8 to 2 mm wide. Petals oblong-linear, acute, about 13 mm long, 3 mm wide. Labellum large, oblong-obovate when expanded, cuneate at the base, slightly retuse, about 10.5 mm long, 11 mm wide when stretched out, with three elevated dentate or lacerate lamellæ near the apex; base of the labellum extended into a short didymous spur about 5 mm long. Column stout in proportion to the size of the flower, semiterete, the margin expanded into a wing along each side. Anther two-horned. Pollinia 8, unequal, in pairs.

PALAWAN, on rocks along the bank of Iwahig River, *Bur. Sci. 81158 E. H. Taylor*, September 18, 1923.

The single collection here cited appears to be referable to *Nephelaphyllum pulchrum* Blume, although the long acuminate leaves seem aberrant from those of the typical form.

This species differs from *N. mindorense* Ames in having much larger flowers and dentate (not subentire) keels on the lip.

Besides the Philippines, it occurs in Borneo, Java, Sumatra, and the Straits Settlements.

Genus PLOCOGLOTTIS Blume

PLOCOGLOTTIS LUCBANENSIS Ames. Plate 1, figs. 7 and 8; Plate 2, figs. 9 to 20.

Plocoglottis lucbanensis AMES in Elm. Leafl. Philip. Bot. 5 (1912) 1572, Orch. 5 (1915) 100, in Merr. Enum. Philip. Fl. Pl. 1 (1924) 338.

"Herba terestris. Caules subcaespitosi, purpurei, ad basim incrassati, fibris elongatis ornati, monophylli. Folium oblongi-lanceolatum, acutum, acuminatum ad basim attenuatum, circiter 3.8 dm. longum, usque ad 3.5 cm. latum in petiolum gracilem elongatum contractum distincte 3-nervium. Scapi aphylli a basi caulium laterales, longi, erecti, circiter 6 dm. longi, vaginati, pubescentes. Racemi abbreviati. Bracteae inflorescentiae lanceolatae, acutae, pubescentes, ± 5 mm. longae. Pedicellus cum ovario circiter 1.2 cm. longus, pubescens. Flores atro-flavidi, purpureo-maculati, pubescentes. Sepala lateralia crassa 12 mm. longa, acuta, ad apicem subcucullata, oblongi-lanceolata, extus pubescentia, 5-nervia. Sepalum posticum oblongum, obtusum. Petala 11 mm. longa, linearia, falcata, ad apicem sensim dilatata et incrassata. Labellum crassum 8 mm. longum, circiter 4 mm. latum, ad apicem in apiculo productum. Apiculus valde deflexus, recurvatus. Columna scabrata.

"Aside from a slight thickening of the nerves the labellum appears to be ecallose.

"LUZON, Province of Tayabas, Lucban, May, 1907, *A. D. E. Elmer*, 7707.

"Small tufted terrestrial herbs in damp soil of wooded ravines at 2,750 feet altitude. Pseudobulbs and stems conspicuously purple; leaves submembranaceous; buds whitish; flower dull yellow, spotted with purple. Rare!"—AMES in Elm. Leafl. Philip. Bot. 5 (1912) 1572.

BABUYAN ISLANDS (CAMIGUIN ISLAND), *Bur. Sci. 4147 Fenix*, July 16, 1907. LUZON, Benguet Subprovince, Baguio, *Phil. Nat. Herb. 50 Mrs. K. B. Day*, May 21, 1934: Laguna Province, *For. Bur. 28939 Willie and Salvoza:* Tayabas Province, Lucban, *Elmer 7707* (type), May, 1907: Sorsogon Province, Irosin, Mount Bulusan, *Elmer 17123*, September, 1916.

The peduncles are purplish; sepals and petals light cadmium and spotted with nopal red; labellum pinard yellow; column pinard yellow at apex and white at base; pedicellate ovary white.

Genus DENDROBIUM Swartz

DENDROBIUM BUKIDNONENSE Ames and Quis. sp. nov. Plate 1, figs. 5 and 6; Plate 3, figs. 1 to 7; Plate 9, fig. 1.

Caules aggregati, 23.5 ad 50 cm longi, basi ovoideo-incrassati, supra attenuati. Folia disticha, linearia, obtusa, 4 ad 7 cm longa, 3 ad 4 mm lata. Racemi breves; flores singuli succedanei, circiter 1.4 cm dimetiente. Sepala lateralia late triangularia, apice rotundato subacuta, 6.5 ad 8 mm longa, circiter 15.6 mm secundum columnae pedem lata, 6- to 7-nervia. Sepalum

dorsale oblongo-ovatum, subacutum, 6 ad 7 mm longum, circiter 3.5 mm latum, 5- to 7-nervium. Petala oblongo-elliptica, obtusa, 5.5 ad 7 mm longa, 2.9 ad 3.5 mm lata, 1-nervia. Labellum cuneato-obovatum, simplex obscurrissime trilobatum, crenulatum, 15.7 ad 18 mm longum, 9 ad 11 mm latum. Columna breve, in pedem perlongum extensa.

Stems aggregated, similar in habit to those of *Dendrobium crumenatum* Sw., 23.5 to 50 cm long. Pseudobulbs or ovoid thickenings at the base of the stems, 2 to 4 cm long, 1.3 to 1.5 cm in diameter, conspicuously many-ridged with rounded angles. Leaves distichous, linear, obtuse, 4 to 7 cm long, 3 to 4 mm wide. Racemes short; the flowers appearing singly, about 1.4 cm across. Lateral sepals broadly triangular, subacute, 6.5 to 8 mm long, about 15.6 mm broad along the column-foot, 6- to 7-nerved. Dorsal sepal oblong-ovate, subacute, 6 to 7 mm long, about 3.5 mm wide, 5- to 7-nerved. Petals oblong-elliptic, obtuse, 5.5 to 7 mm long, 2.9 to 3.5 mm wide, 1-nerved. Spur or mentum conical with elongated apex. Labellum simple, cuneate-obovate, crenulate on the anterior margins, 15.7 to 18 mm long, 9 to 11 mm wide when expanded at the broadest portion. Disc with slightly thickened veins—especially the central one—and with scattering papillæ at the center near the apex. Column very short, extended into a very long foot.

LUZON, Manila, Bureau of Science orchid house, *Bur. Sci. 85617 E. Quisumbing*, December 14, 1932. Living specimens were presented to the junior author by Mr. L. H. Phillips, formerly of Bukidnon, Mindanao, who collected them from the hills of Bukidnon. The plants have flowered several times in the Bureau of Science orchid house during the months of July, August, and December. The flowers are not fugacious (remaining fresh for two days) and are slightly fragrant. The sepals are marguerite yellow. The petals almost white with a slight tinge of primrose yellow at the tips, and the spur slightly cream-colored; the ridge at the middle of the labellum apricot yellow.

This species is allied to *Dendrobium gracile* (Bl.) Lindl., but differs in not having subulate leaves, in its oblong-ovate dorsal sepal, and in the color of the flowers.

Genus BROMHEADIA Lindley

BROMHEADIA PHILIPPINENSIS sp. nov. Plate 1, figs. 1 and 2; Plate 4; Plate 9, fig. 2.

Herba epiphytica. Caules e rhizomate ramoso exorti, complanati, erecti, 26 ad 54 cm alti, vaginis foliorum omnino obtecti;

internodia 2 ad 3 cm longa. Folia disticha, patentia, ligulata, subcoriacea, 10.5 ad 17.5 cm longa, 1.1 ad 1.6 cm lata, apice valde bilobata, lobis inaequilateralibus. Inflorescentia terminalis, 4 ad 6 cm longa, simplex, fere sessilis; bracteae distichae, rigidae, imbricantes, cymbiformes, acutae, 6 ad 8 mm longae. Flores singuli apparentes, albi, odorati, 2.5 ad 2.6 cm longi, 2.2 ad 2.4 cm dimetiente. Pedicellus cum ovario gracilis, circiter 1.4 cm longus. Sepala lateralia lanceolata, paulo obliqua, carinata, acuta, circiter, 2.3 cm longa, 7 mm lata. Sepalum dorsale oblanceolato-oblongum, acutum, circiter 2.5 cm longum, 7 mm latum. Petala anguste lanceolata vel anguste oblanceolata, obliqua, acuta, circiter 2.2 cm longa, 5.75 mm lata. Labellum in circuitu late oblongum, brevissime unguiculatum, supra medium trilobatum, circiter 1.7 cm longum et 9.5 mm latum; lobi laterales parvi, ovato-triangulares, obtusi, 2 ad 2.5 mm longi; lobus medius subquadratus, antice truncatus et minute apiculatus, 6 ad 6.5 mm latus, medio calloso-elevato et flavo. Discus cum parte longitudinali centrali calloso-elevata pubescenti in callum distinctum terminanti. Columna crassiuscula, recta, vel paulo incurvata, antice excavata, circiter 14 mm longa. Clinandrium parvum; anthera late ovoidea, apice obtusa, margine anteriore profunde emarginato. Pollinia 2, triangulari-ovoidea, dorso excavata.

Plants growing ascendingly on tree trunks. Roots fibrous, flexuous, stout, glabrous. Stems flattened, 26 to 54 cm long, arising from terete, branching rhizomes; internodes shortest at base, 2 to 3 cm long, entirely or almost entirely concealed by the flattened leaf-sheaths. Leaves distichous, ligulate, subcoriaceous when dry, 10.5 to 17.5 cm long, 1.1 to 1.6 cm wide, strongly bilobed at the apex with the lobes inequilateral. Inflorescence terminal, simple, almost sessile, 4 to 6 cm long; bracts distichous, rigid, imbricated, cymbiform, acute, 6 to 8 mm long. Flowers appear singly, rather fleshy, white, fragrant, 2.5 to 2.6 cm long, 2.2 to 2.4 cm across. Pedicellate ovary slender, about 1.4 cm long. Lateral sepals lanceolate, oblique, carinate near the apex, acute, about 2.3 cm long, 7 mm wide. Dorsal sepal oblanceolate-oblong, acute, about 2.5 cm long, 7 mm wide. Petals narrowly lanceolate or narrowly oblanceolate, oblique, acute, about 2.2 cm long, 5.75 mm wide. Labellum very slightly unguiculate, broadly oblong, trilobed in outline above the middle, about 1.7 cm long and 9.5 mm wide; lateral lobes very small, ovate-triangular, obtuse, 2 to 2.5 mm long; middle lobe subquadrate, truncate and minutely apiculate, 6 to 6.5 mm wide, with the center callose-elevated and yellow.

Disc with a central longitudinal fleshy pubescent zone ending in a distinct callus. Column thick, straight or slightly incurved, concave in front, with winged margins, about 14 mm long. Clinandrium small; anther broadly ovoid, obtuse at the apex, cucullate. Pollinia 2, triangular-ovoid, the dorsal side excavated, about 1.5 mm long.

MINDANAO, Zamboanga Province, Mount Silingan, *Phil. Nat. Herb. 3000 Mrs. K. B. Day*, November, 1934.

The description was based on living specimens given to the junior author by Mrs. Day and now cultivated in the Bureau of Science orchid house. The flowers have the general appearance and habit of opening of *Sarcochilus pallidus*. Pedicellate ovary chalcedony yellow; sepals and petals white with naphthalene yellow tips; labellum white with the callus on the front lobe apricot yellow; column naphthalene yellow.

The genus *Bromheadia* is new to the Philippines. *Bromheadia philippinensis* is apparently closely allied to *B. alticola* Ridl., but differs in its apparently dissimilar habit of growth and the obtuse outward-pointing side lobes of the lip.

Genus ASCOGLOSSUM Schlechter

ASCOGLOSSUM CALOPTERUM (Reichb. f.) Schltr. Plate 1, figs. 12 and 13; Plate 5, figs. 1 to 10.

Ascoglossum calopterum (Reichb. f.) SCHLTR. in Fedde Repert. Beihefte 1 (Orchidaceen von Deutsch-Neu Guinea) (1914) 975; 21 (Fig. Atlas) (1923) *t. 343*, No. 1324.

Saccolabium calopterum REICHB. F. in Gard. Chron. (1882) 2: 520.

Cleisostoma cryptochilum F. v. MUELL. in Wing South Sci. Rec. n. 5 1 (1885).

Saccolabium Schleinitzianum KRANZL. in Engl. Bot. Jahrb. 7 (1886) 440.

Caules erecti vel curvati, rigidi, teretes, 20 ad 30 cm longi, vix 1 cm dimetiente. Folia disticha, rigida, ligulata, approximata, valde coriacea, apice rotundato inaequaliter obtuse bilobata, 11 ad 18.5 cm longa, 2 ad 3 cm lata. Inflorescentiae laterales paniculatae, multiflorae, 20 ad 35 cm longae; pedunculus erectus, rigidus, 12 ad 15 cm longus, vaginis brevibus tubularibus, 4 ad 5 mm longis ornatus. Pedicellus cum ovario gracilis, 11 ad 15 mm longus. Flores inodori feri, purpurei, 15 ad 17 mm longi, 6 ad 8 mm dimetiente; perianthii parte valde reflexae. Sepala lateralia unguiculata, acuta vel obtusa, 9 ad 12 mm longa, 4.5 ad 5 mm lata, ad basim vix 1.25 mm lata, supra medium lobulo ovato-triangulari plus minusve distincto ornata. Sepalum dorsale oblongo-oblanceolatum, acutum vel

subacutum, 9 ad 10.5 mm longum, 3 ad 3.25 mm latum. Petala elliptico-lanceolata, apice attenuata, acuta, 8.5 ad 9.5 mm longa, 2.75 ad 3 mm lata. Labellum calcaratum, trilobatum; lobi laterales erecti, apice oblique truncati, postice ad columnam attingentes; lobus medius e calcaris medio exoriente, minutus, reflexus, lineari-lanceolatus, apice obtusus, 2.5 ad 3 mm longus, 0.75 ad 0.9 mm latus. Calcar cylindricum, leviter curvatum, apice lateraliter abrupte inflatum et rotundatum, 10.25 ad 11 mm longum. Columna rigida, perbrevis, crassa, 4.5 ad 5 mm alta. Anthera obovoidea, 1.7 ad 1.8 mm longa. Pollinia oblonga.

Roots dark gray, elongate, 3.5 to 4 mm in diameter. Stems erect or curved, rigid, terete, 20 to 30 cm long, about 1 cm in diameter. Leaves distichous, rigid, ligulate, approximate, very leathery, unequally bilobed at the rounded apex with obtuse lobules, 11 to 18.5 cm long, 2 to 3 cm wide. Panicles lateral, many-flowered, 20 to 35 cm long; peduncles erect, rigid, 12 to 15 cm long; sheaths short, tubular, 4 to 5 mm long. Pedicellate ovary slender, 11 to 15 mm long. Flowers odorless, 15 to 17 mm long, 6 to 8 mm wide. Lateral sepals unguiculate, parallel, oblanceolate, acute or obtuse, 9 to 12 mm long, 4.5 to 5 mm wide, the very base about 1.25 mm wide, above the middle provided with a more or less distinct triangular-ovate lobule. Dorsal sepal oblong-oblanceolate, acute or subacute, 9 to 10.5 mm long, 3 to 3.25 mm wide. Petals parallel, elliptic-lanceolate, narrowed to the acute apex, 8.5 to 9.5 mm long, 2.75 to 3 mm wide. Labellum spurred, trilobed; lateral lobes erect, obliquely truncate at the apex, attached to the column at the base; middle lobe very small, linear-lanceolate, reflexed, obtuse at the tip, 2.5 to 3 mm long, 0.75 to 0.9 mm wide. Spur cylindric, elongate, curved, laterally abruptly dilated and rounded at the apex, 10.25 to 11 mm long, 3 to 3.5 mm in diameter at the very apex, when viewed from the front. Column rigid, very short and thick, 4.5 to 5 mm high. Anther obovoid, 1.7 to 1.8 mm long. Pollinia oblong.

DINAGAT ISLAND, Osmeña, Dinagat, *Phil. Nat. Herb. 387 L. E. Hachero*, October, 1933. Growing on tree trunks in the coastal forests on Dinagat Island, northeast of Mindanao. Living plants were sent to the junior author through Dr. E. B. Copeland, formerly of the Economic Garden, Bureau of Plant Industry, and have flowered in the Bureau of Science orchid house twice—May 12, 1934, and March 6, 1935. The flowers remain fresh on the plant for two weeks.

Sepals and petals rosolane purple dotted with true purple; pedicellate ovary aster purple; middle lobe of the labellum and throat onion skin pink; spur pomegranate purple.

A very interesting species with very leathery dark green leaves and conspicuous purple flowers, of which the lateral sepals and petals are reflexed and parallel. It differs from any typical *Renanthera* in its long clavate spur and minute narrow middle lobe of the labellum.

This species belongs to the genus *Ascoglossum* Schltr., a new genus for the Philippines. The genus is closely allied to *Renanthera* but differs in that the lateral lobes reach much higher than the mid-lobe.

Genus TRICHOGLOTTIS Blume

TRICHOGLOTTIS AGUSANENSIS Ames and Quis. sp. nov. Plate 1, figs. 10 and 11; Plate 6, figs. 1 to 10.

Herba epiphytica, erecta, rigida, 22 ad 35 cm alta. Caules foliosi, internodiis 2 ad 3 cm longis. Foliorum vaginae cylindricae, internodiis vix aequilongae. Folia disticha, ligulata, coriacea, in sicco rugosa, 14 ad 15.5 cm longa, 1.7 ad 2 cm lata, apice inaequaliter rotundato-bilobata. Inflorescentiae oppositifoliae, paniculatae, 12 ad 13 cm longae, 10- ad 12-florae. Bracteae inflorescentiae rigidae, squamiformes, 1.5 ad 2 mm longae. Flores carnosi, 16 ad 17 mm dimetiente. Sepala lateralia ovato-elliptica, acuta vel subacuta, 8.5 ad 9.5 mm longa, 6 ad 6.5 mm lata. Sepalum dorsale obovato-ellipticum, apice late rotundatum, 9 ad 10 mm longum, 6 ad 6.5 mm latum. Petala elliptico-obovata, apice rotundata, 8.5 ad 9 mm longa, 4.5 ad 5.5 lata. Labellum basi breviter saccatum, 3-lobatum, 8 ad 9 mm longum; lobi laterales breves, erecti, indistincti, 1 ad 1.25 mm alti; lobus medius lanceolatus, antice attenuatus, supra medium abrupte inflexus, apice ipso truncato-dilatatus. Discus valde calloso-incrassatus et pubescens.

Epiphytes with elongated roots. Stems rigid, foliose, erect or more or less arcuate, 22 to 35 cm high; internodes 2 to 3 cm long. Leaf sheaths cylindric, almost as long as the internodes. Leaves distichous, ligulate, coriaceous, rugose when dry, 14 to 15.5 cm long, 1.7 to 2 cm wide, unequally bilobed at the apex with rounded lobules. Inflorescences opposite the leaves, shorter than the leaves, paniculate, 12 to 13 cm long, 10- to 12-flowered. Bracts of the fractiflex inflorescence rigid, squamiform, concave, 1.5 to 2 mm long. Flowers fleshy, odorless, 16 to 17 cm across. Pedicellate ovary, 10 to 11 mm long. Lateral sepals ovate-

elliptic, acute or subacute, 8.5 to 9.5 mm long, 6 to 6.5 mm wide. Dorsal sepal obovate-elliptic, broadly rounded at the apex, 9 to 10 mm long, 6 to 6.5 mm wide. Petals elliptic-obovate, rounded at the apex, 8.5 to 9 mm long, 4.5 to 5.5 mm wide. Labellum 3-lobed, shallowly saccate at base, 8 to 9 mm long; lateral lobes short, erect, indistinct, with free portion 1 to 1.25 mm high; middle lobe lanceolate, attenuate toward the apex, above the middle abruptly inflexed, truncate dilated at the very tip. Disc strongly callose-thickened and pubescent through the center. Between the basal lobes there is a ligulate, pubescent upcurved appendage which is about 2.5 mm long. Gynostemium very short and stout, pubescent, with a pair of falcate, narrow, elongate, pubescent auricles which are 2.5 to 3 mm long.

LUZON, Rizal Province, Mariquina, Mrs. M. L. Quezon's gardens, *Phil. Nat. Herb. 3005 E. Quisumbing*, January 16, 1935.

The living plants were sent from Agusan by Attorney José Rodriguez. Pedicellate ovary lumiere green. Sepals and petals bright chalcedony yellow lined with vinaceous rufous. Lateral lobes of the lip white; the middle lobe white with two eugenia red lines above, apex and base between the lateral lobes cadmium yellow, callus white.

This species is allied to *Trichoglottis ionosma* (Lindl.) J. J. Sm., but is a much smaller plant throughout with less prominent spurred base to the lip.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Bromheadia philippinensis* Ames and Quis. sp. nov., front view of flower, × 1.

2. *Bromheadia philippinensis* Ames and Quis. sp. nov., side view of flower, × 1.
3. *Nephelaphyllum mindorense* Ames, front view of flower, × 2.
4. *Nephelaphyllum mindorense* Ames, side view of flower, × 2.
5. *Dendrobium bukidnonense* Ames and Quis. sp. nov., front view of flower, × 2 (circa).
6. *Dendrobium bukidnonense* Ames and Quis. sp. nov., side view of flower, × 2 (circa).
7. *Plocoglottis lucbanensis* Ames, front view of flower, × 1.
8. *Plocoglottis lucbanensis* Ames, side view of flower, × 1.
9. *Malaxis purpureiflora* Ames and Quis. sp. nov., front view of flower (natural position), × 3 (circa).
10. *Trichoglottis agusanensis* Ames and Quis. sp. nov., front view of flower, × 2.
11. *Trichoglottis agusanensis* Ames and Quis. sp. nov., side view of flower, × 2.
12. *Ascoglossum calopterum* (Reichb. f.) Schltr., front view of flower, × 1.
13. *Ascoglossum calopterum* (Reichb. f.) Schltr., side view of flower, × 1.

PLATE 2

Malaxis purpureiflora Ames and Quis. sp. nov.: *1*, dorsal sepal, × 5.5; *2*, petal, × 5.5; *3*, lateral sepal, × 5.5; *4*, front view of column and labellum (natural position), × 5.5; *5*, side view of ovary, column, and labellum (natural position) × 5.5; *6*, anther from above, × 14; *7*, anther from below, × 14; *8*, pollinia, very much enlarged. (All figures drawn with aid of camera lucida.)

Plocoglottis lucbanensis Ames: *9*, dorsal sepal, from back, × 2; *10*, side view of dorsal sepal, × 2; *11*, petal (flattened), × 2; *12*, exterior view of lateral sepal, × 2; *13*, side view of lateral sepal, × 2; *14*, side view of ovary, column, and labellum (natural position), × 4; *15*, front view of column, × 4; *16*, column and labellum (natural position) from above, × 4; *17*, labellum from above (natural position), × 4; *18*, labellum from above (stretched out), × 4; *19*, anther from above, × 7; *20*, anther from below, × 7. (Figs. 19 and 20 were drawn with the aid of a camera lucida.)

Nephelaphyllum mindorense Ames: *21*, dorsal sepal, × 3; *22*, petal, × 3; *23*, lateral sepal, × 3; *24*, side view of ovary, column, and labellum (natural position), × 3; *25*, labellum from above (natural position), × 3; *26*, labellum from above (stretched out), × 3; *27*, front view of spur, × 4; *28*, front view of column, × 3; *29*, side view of column, × 3; *30*, anther from above, × 5.5; *31*, anther from below, × 5.5. (Figs. 30 and 31 were drawn with the aid of a camera lucida.)

PLATE 3

Dendrobium bukidnonense Ames and Quis. sp. nov.: *1*, dorsal sepal, × 7; *2*, petal, × 7; *3*, lateral sepal, × 7; *4*, labellum from above (somewhat expanded), × 4; *5*, side view of ovary and column, × 7; *6*, front view of column, × 7; *7*, anther, × 11.

PLATE 4

Bromheadia philippinensis sp. nov.: *1*, dorsal sepal, × 2; *2*, petal, × 2; *3*, lateral sepal, × 2; *4*, labellum from above (natural position), × 4; *5*, labellum from above, (stretched out), × 4; *6*, front view of column, × 4; *7*, side view of column, × 4; *8*, pollinia, × 12.

PLATE 5

Ascoglossum calopterum (Reichb. f.) Schltr.: *1*, habit, one-third natural size; *2*, dorsal sepal, × 2.66 (circa); *3*, petal, × 2.66 (circa); *4*, lateral sepal, × 2.66 (circa); *5*, front view of flower, × 2; *6*, side view of flower, × 2; *7*, longitudinal section of the labellum and spur, × 2; *8*, anther from above, × 4.66 (circa); *9*, anther from above, × 4.66 (circa); *10*, pollinia, × 4.66 (circa). (Figs. 8 to 10 drawn with aid of camera lucida.)

PLATE 6

Trichoglottis agusanensis Ames and Quis. sp. nov.: *1*, habit, one-third natural size; *2*, dorsal sepal, × 1.33 (circa); *3*, petal, × 1.33 (circa); *4*, lateral sepal, × 1.33 (circa); *5*, side view of ovary, column, and labellum (natural position), × 2; *6*, front view of column and labellum (natural position), × 2; *7*, column and labellum from above (natural position), × 2; *8*, anther from above, × 4; *9*, anther from below, × 4; *10*, pollinia, × 4.

PLATE 7

Malaxis purpureiflora Ames and Quis. sp. nov.: habit, much reduced.

PLATE 8

Nephelaphyllum mindorense Ames: habit, slightly larger than natural size.

PLATE 9

FIG. 1. *Dendrobium bukidnonense* Ames and Quis. sp. nov.: habit, very much reduced.

2. *Bromheadia philippinensis* Ames and Quis. sp. nov.: habit, very much reduced.

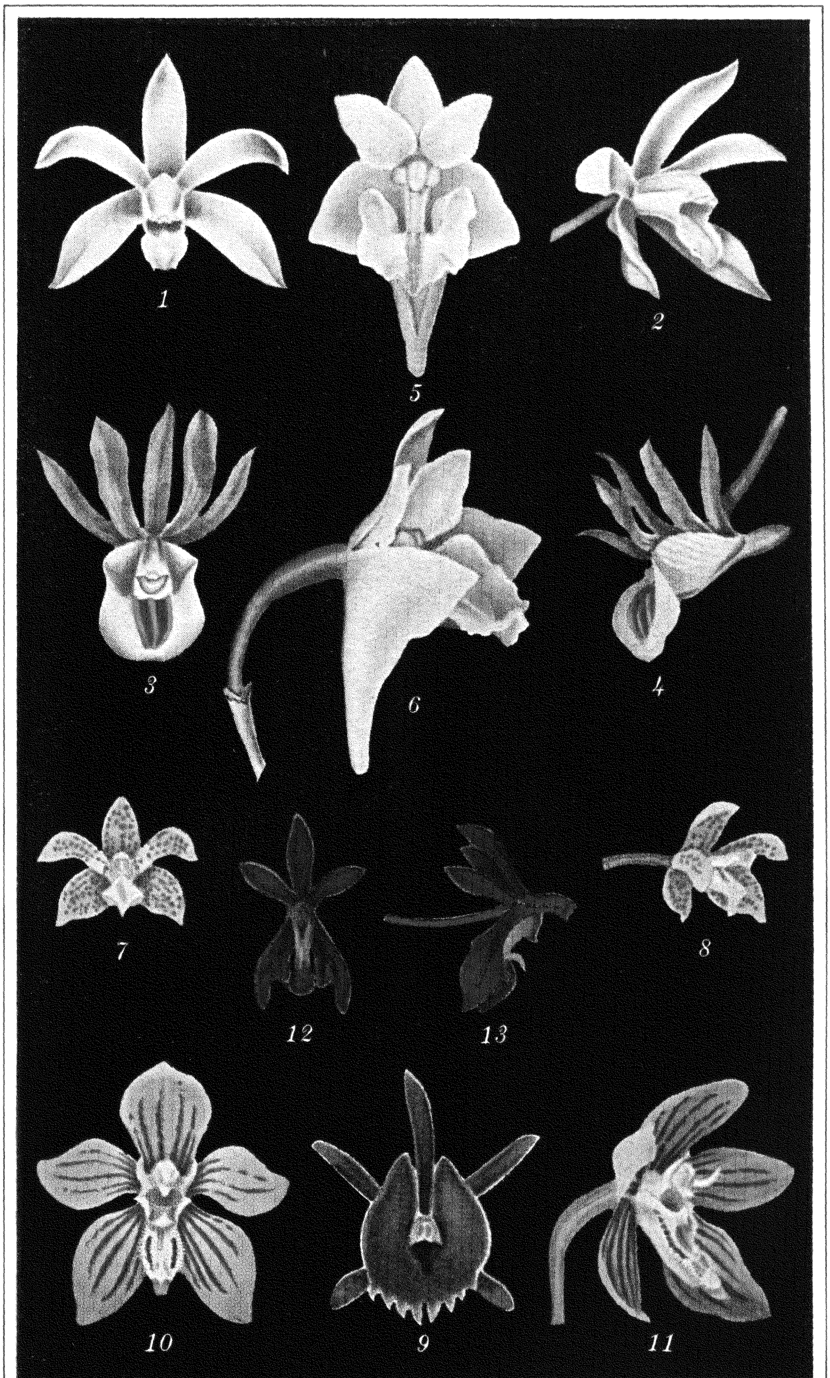

PLATE 1.

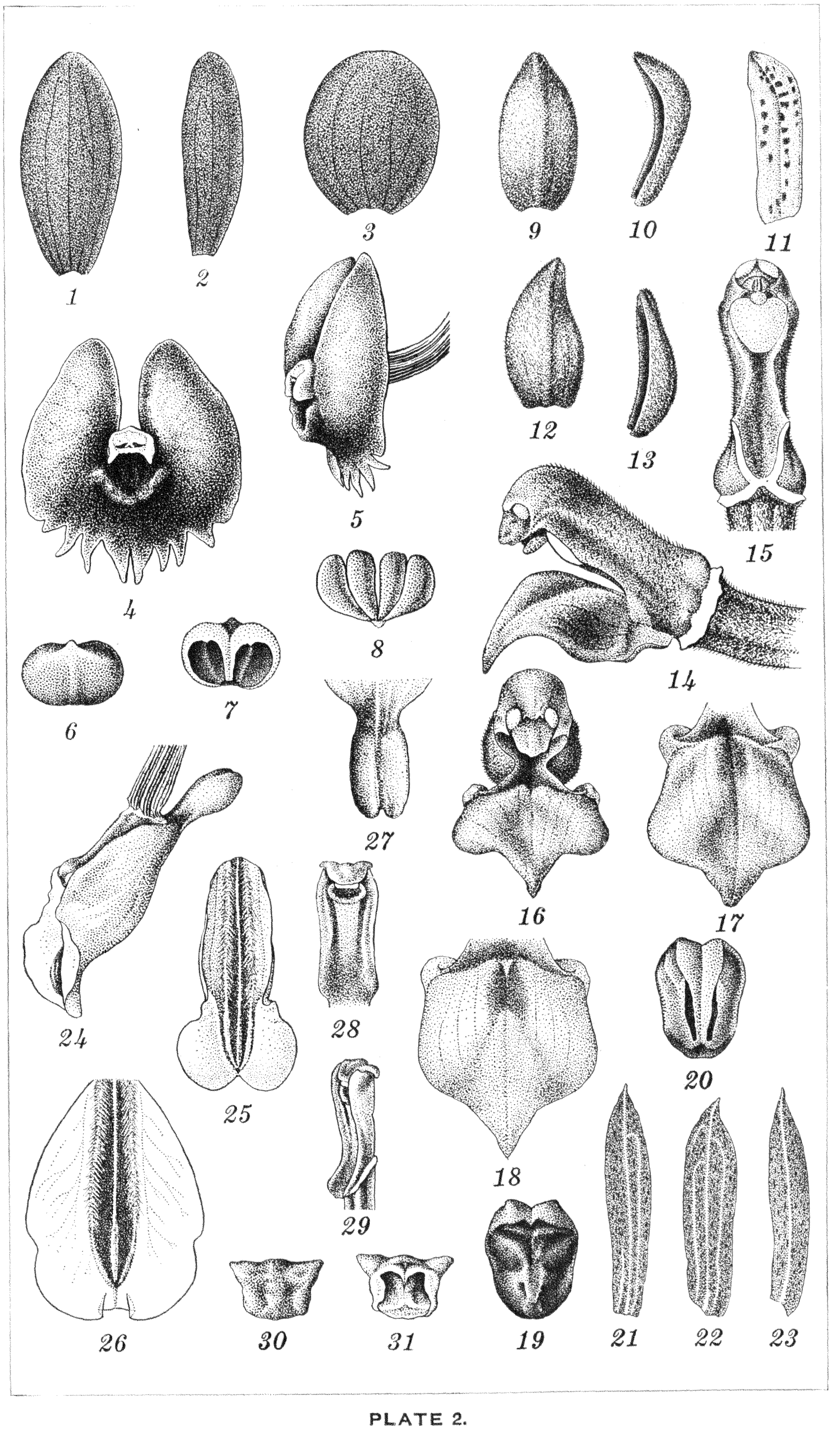
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PLATE 2.

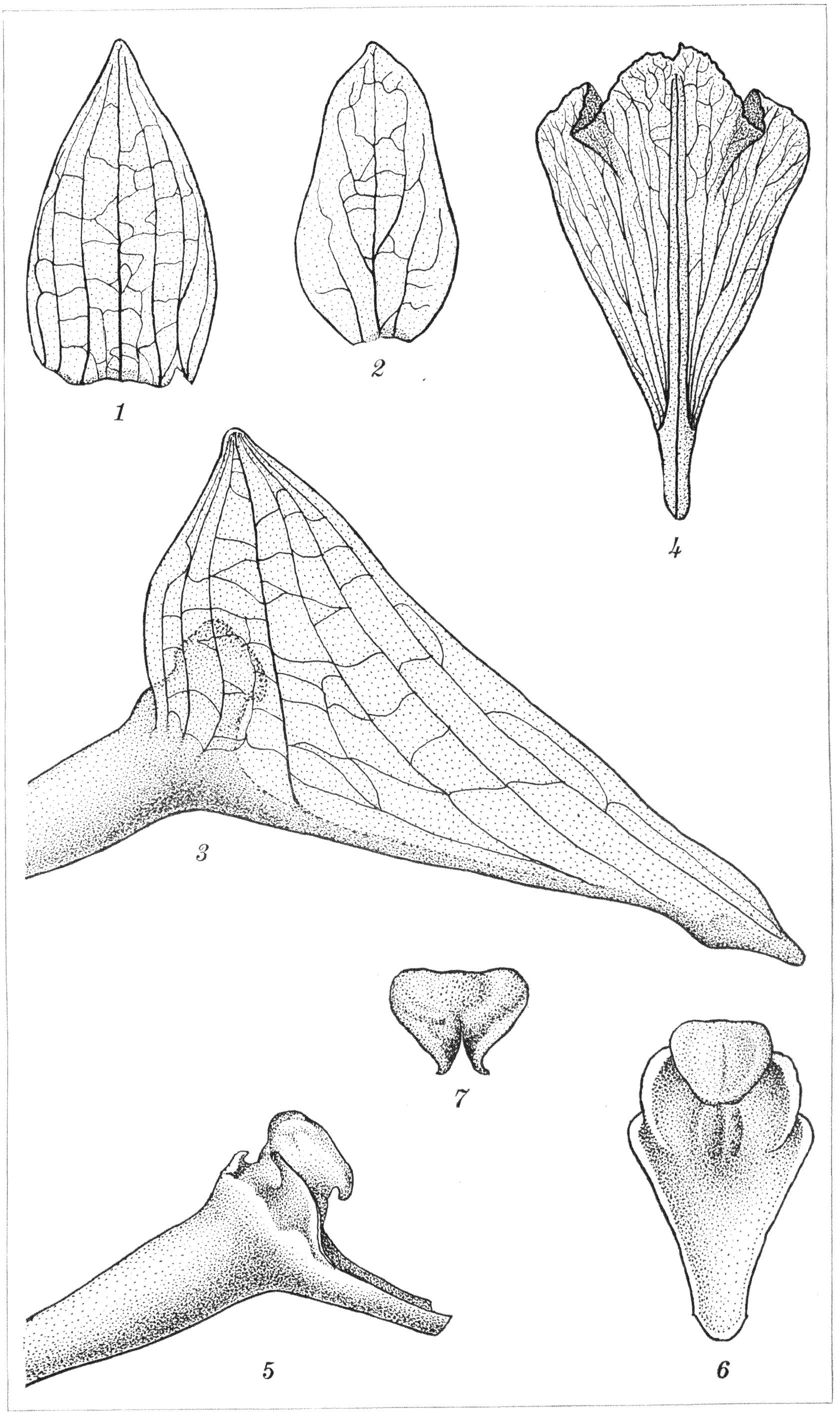

PLATE 3.

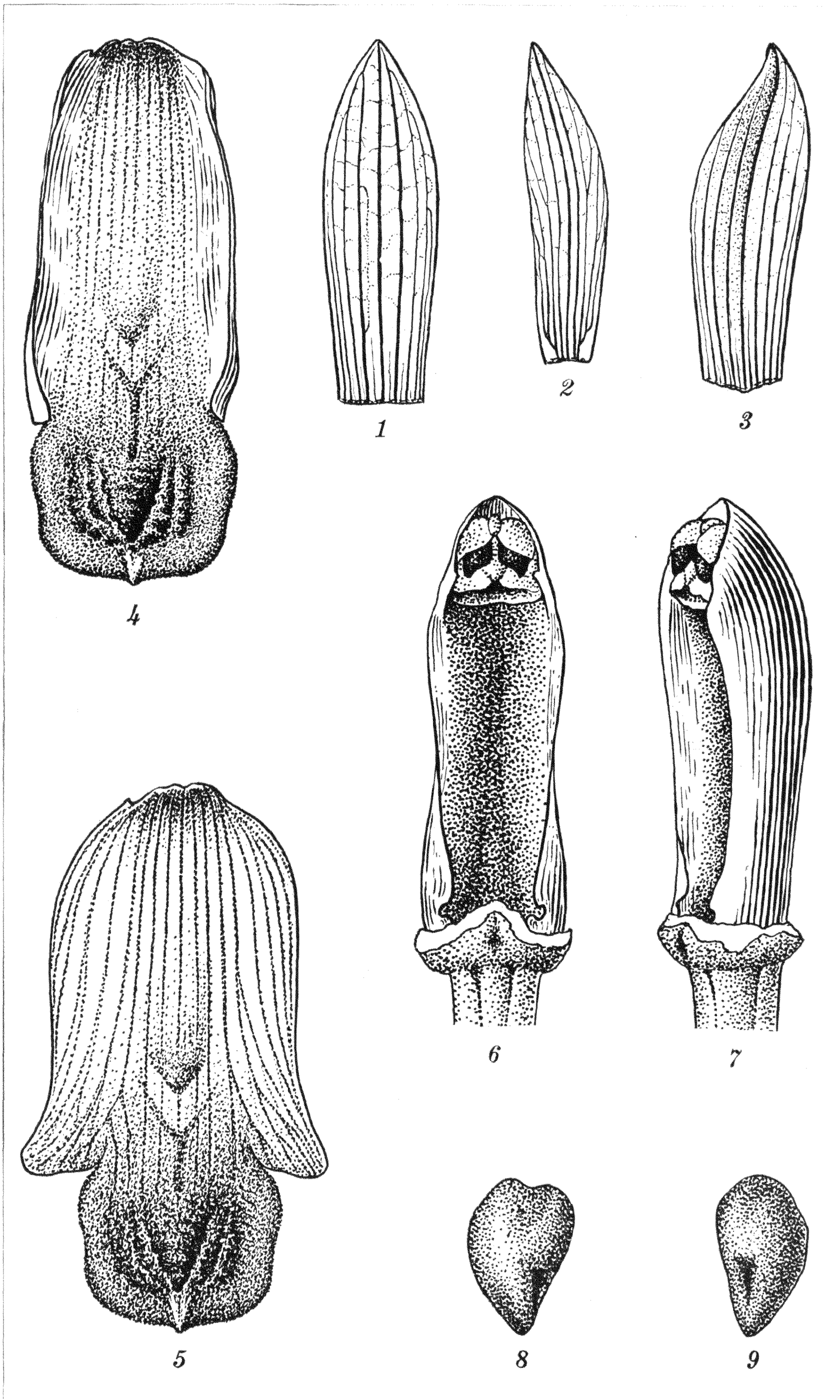

PLATE 4.

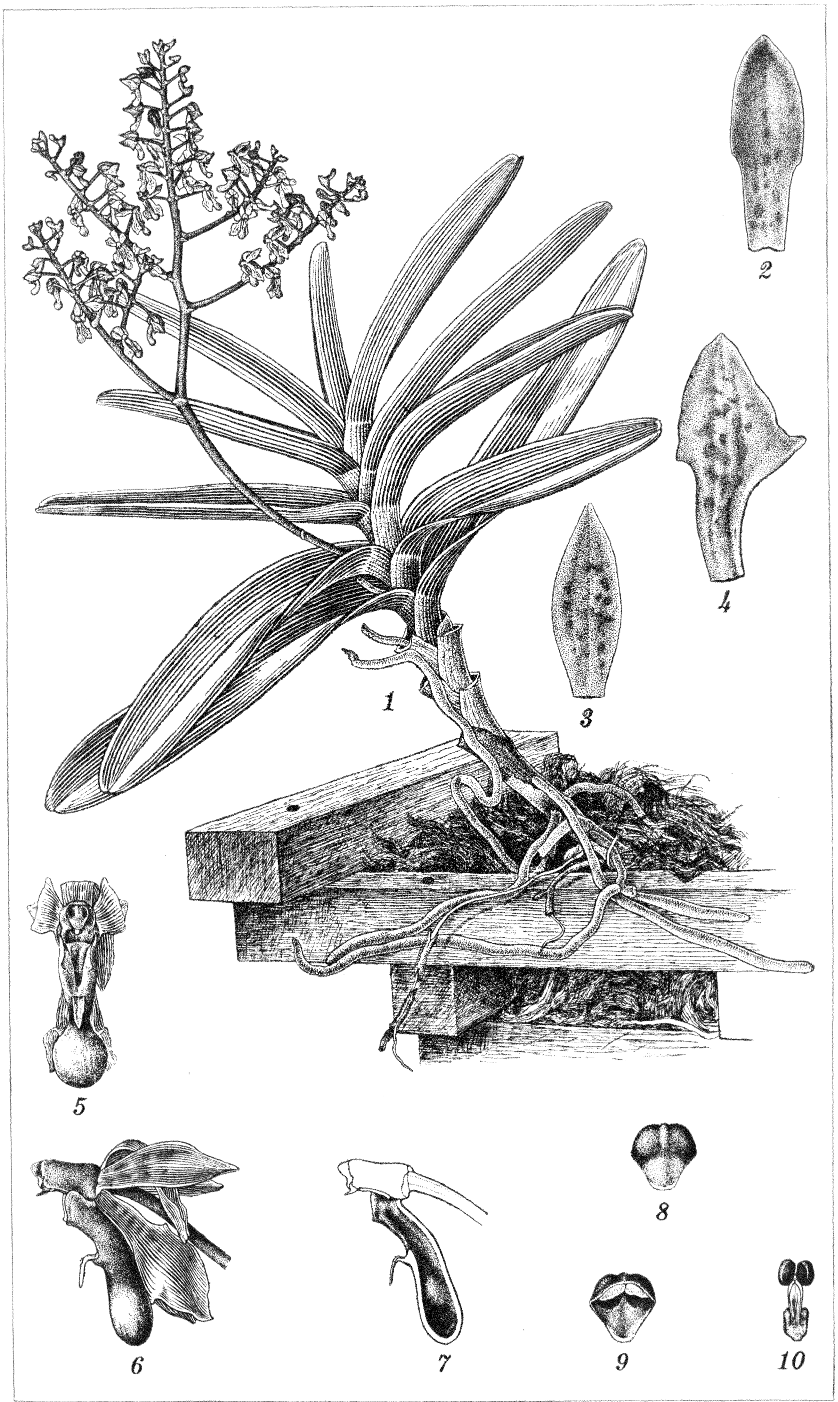

PLATE 5.

PLATE 6.

PLATE 7.

PLATE 8.

PLATE 9.

A PRACTICAL ILLUSTRATED KEY TO ADULTS OF PHILIPPINE ANOPHELES [1]

By PAUL F. RUSSELL

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and

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THIRTY-FOUR PLATES AND SIX TEXT FIGURES

INTRODUCTION

The authors wish to emphasize the fact that this key is not presented as a research study in entomology, but as a practical aid to malaria studies in the Philippines. No key to the local adult anophelines has been printed, and the need for one is great. This key is subject to revision, as there remains a considerable amount of systematic study to be done, especially on eggs and pupæ. Our key is original in that every drawing is a new one made directly from specimens collected by us or reared and prepared in our laboratory. Our key is based on the work of many authors who have published their observations regarding the local anophelines.

The papers by Ludlow,(1) Banks,(2) Mieldazis,(3) Manalang,(4) Baisas,(5) and King(6) have been of special importance

[1] The senior author formerly was chief of Malaria Investigations which was jointly supported by the Bureau of Science, Manila, and the International Health Division of The Rockefeller Foundation. The junior author has been detailed to Malaria Investigations by courtesy of Dr. J. Fajardo, director, Philippine Bureau of Health. We are indebted to the following for assistance at various times during the year in which we have been preparing this paper: Messrs. Andres M. Nono and Domingo Santiago, Miss Amparo Capistrano, and Mrs. Isabel V. Ramos, all of the staff of Malaria Investigations. All of the drawings are original and were prepared from specimens caught or reared by the staff of Malaria Investigations. We are indebted to the artists, Messrs. Eliseo Enriquez and Alejandro Rosario, for their painstaking work. We would also acknowledge the work of the photographic section of the Bureau of Science for painstaking care with many of the plates, not only of this paper but also of our larval key.

in developing our knowledge of Philippine *Anopheles*. Recent comprehensive publications by Edwards(7) and Christophers(8) have been very useful. The latter(8) gives numerous references to papers by various authors regarding wing venation, male genitalia, and other characters. Soesilo and van Hell(9) have recently revised Rodenwaldt's chart of the *Anopheles* of the Netherlands Indies. It contains certain forms also found in the Philippines. Russell(10) gives a complete bibliography, as regards the Philippines, of publications relating to mosquitoes and malaria from 1898 to 1933.

In using a key to mosquito species it should be remembered that there is often individual variation. Therefore, more than one character should be used. Habitat will sometimes be of help. If there remains any doubt about diagnosis the insect should be sent to the malaria control section of the Bureau of Health, Manila.

DESCRIPTION OF CHARACTERS USED IN SEPARATING ANOPHELES ADULTS

A. SIZE AND COLOR

Species differ in size and color. This fact may sometimes be of use in classification, although not often. Size may be judged by wing length. Anophelines of average size have wings from 4 to 4.5 millimeters in length. Small species have wings measuring about 3 millimeters, and large species about 5 to 6 millimeters.

Colors vary from light gray to dark brown or almost black. Individuals of the same species, however, may vary. Occasionally the dark markings are abnormally increased or decreased. If increased, the condition is called "melanism." If decreased, it is called "hypomelanism." In our description of species we have indicated the cases in which coloration or size is of use for practical identification purposes.

B. THE HEAD

The typical head parts—namely, antennæ, clypeus, palpi, labium or proboscis with its labella, mandibles and maxillæ, vertex and vertical tuft—are shown in text fig. 1. These structures should be known to one who is interested in the identification of mosquitoes.

The male has markedly plumose or feathery antennæ. These differences and also those between male and female palpi are

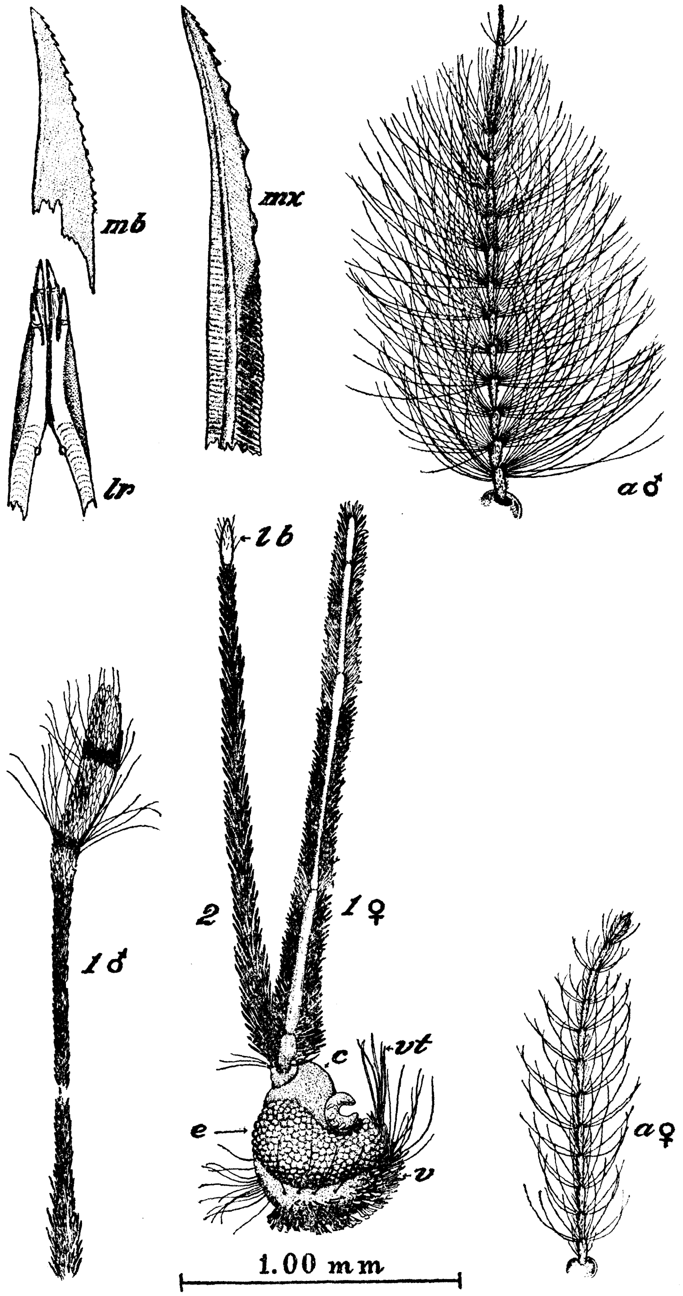

FIG. 1. *Anopheles maculatus* Theobald; head parts; *1*, palp; *2*, proboscis; *lb*, labella; *a*, antenna; *c*, clypeus; *lr*, tip of labium-epipharynx; *mb*, mandible; *mx*, maxilla; *v*, vertex; *vt*, vertical tuft; *e*, eye. (Camera-lucida drawing, semidiagrammatic.)

shown in text fig. 1. The ratio between the length of segment 5 and that of 4 in the female gives the "palpal index," which varies from 1:3 to 1:7 in different species. In the male segments 4 and 5 are expanded and somewhat flattened.

The ornamentation of the palpi is sometimes of importance in differentiating species. It consists of bands of pale scales. These bands vary in width and arrangement. There may be three or four bands, located at the apex and at joint 3–4 and 2–3. If the apical segment is short it usually presents only one band, but if it is long it may present two.

C. THE PHARYNX

We have not used pharyngeal characters, or the so-called "buccopharyngeal armature," in our key; but this microscopical structure has considerable value and has been studied by several investigators. For further information Sinton and Covell,(11) Barraud and Covell,(12) and Christophers(8) should be consulted. For Philippine species see Manalang.(13)

D. THE THORAX

The thorax (text fig. 2) consists of three parts; namely, the prothorax, the mesothorax, and the metathorax. The mesothorax forms most of the clearly visible thorax and its dorsal or upper side is called the "mesonotum." Text fig. 2 shows also the anterior pronotal lobe, the pleura and propleural hairs, and the scutellum.

For more details regarding the thorax, Christophers(8) should be consulted. The mesonotum may have hairs, hairlike scales, or true scales, or it may be bare and shiny. The character of the fossa of the mesonotum may be of value. It may or may not have broad flat scales, and the number of these scales may vary.

E. THE WINGS

The characters of the wings of *Anopheles* are very important in differentiating species, and one should be thoroughly familiar with these structures. The essential characters are shown diagrammatically in text fig. 3. The venation is shown in the upper part of this text figure. The "longitudinal veins" are numbered 1 to 6. Some of the veins have two branches. These are known as "anterior" and "posterior" branches, the anterior being nearer the head when the wings are spread. In the diagram, for example, longitudinal vein 2 has two branches,

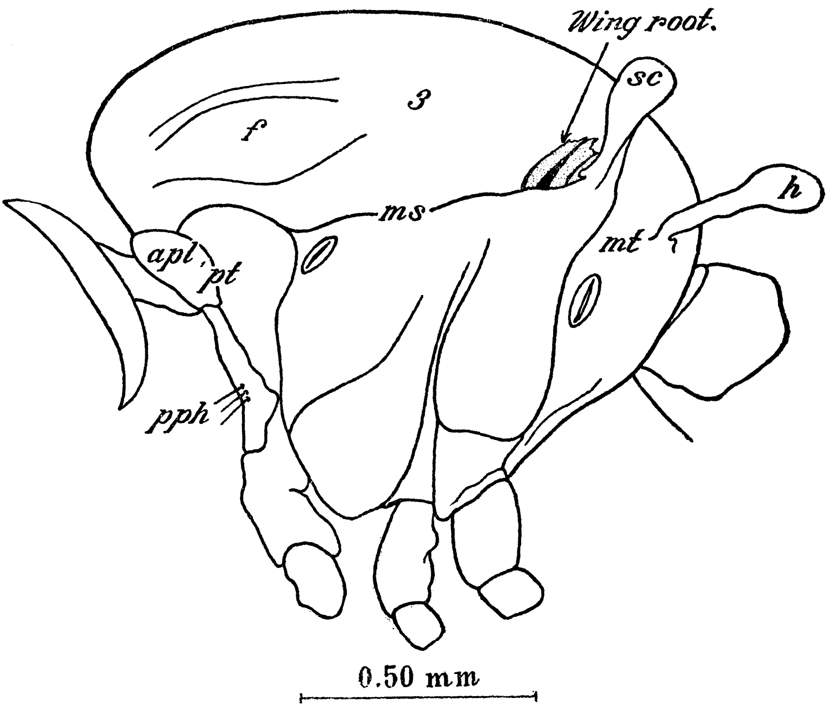

FIG. 2. ***Anopheles maculatus*** **Theobald; thorax; *pt*, prothorax; *ms*, mesothorax; *mt*, metathorax; *3*, mesonotum; *apl*, anterior pronotal lobe; *pph*, propleural hairs; *sc*, scutellum; *h*, halteres; *f*, fossa. (Camera-lucida drawing, semidiagrammatic.)**

numbered 2.1 and 2.2, anterior and posterior, respectively. There are also some "crossveins," as illustrated. Other essential parts of the wing are shown. These are *a*, the apex; *b*, the base; *C*, the costa; *Sc*, the subcosta; *f*, the fringe; *hv*, the humeral crossvein; *cv*, 2–3, crossvein between vein 2 and vein 3 (other crossveins are similarly named); *af*, the anterior forked cell; *pf*, the posterior forked cell.

The petiole of the anterior or posterior forked cells is that part of the main vein from the bifurcation, which forms the cell, to the crossvein. For instance, the petiole of the posterior forked cell extends from crossvein 3–4 to the bifurcation of vein 4. In separating *Anopheles leucosphyrus* from *A.* near-*leucosphyrus* in our key, we have used the following index:

$$\frac{\text{Length of petiole of posterior forked cell.}}{\text{Length of 4.2.}}$$

We have called this the "posterior petiole index" for convenience. It is not the same as the "forked-cell index," which

is obtained by dividing the length of 2.2 by that of 4.2. Some authors have used also an anterior petiole index. These indices vary considerably in the same species, but the one we have used seems to have real value in separating *A. leucosphyrus* from *A.* near-*leucosphyrus*.

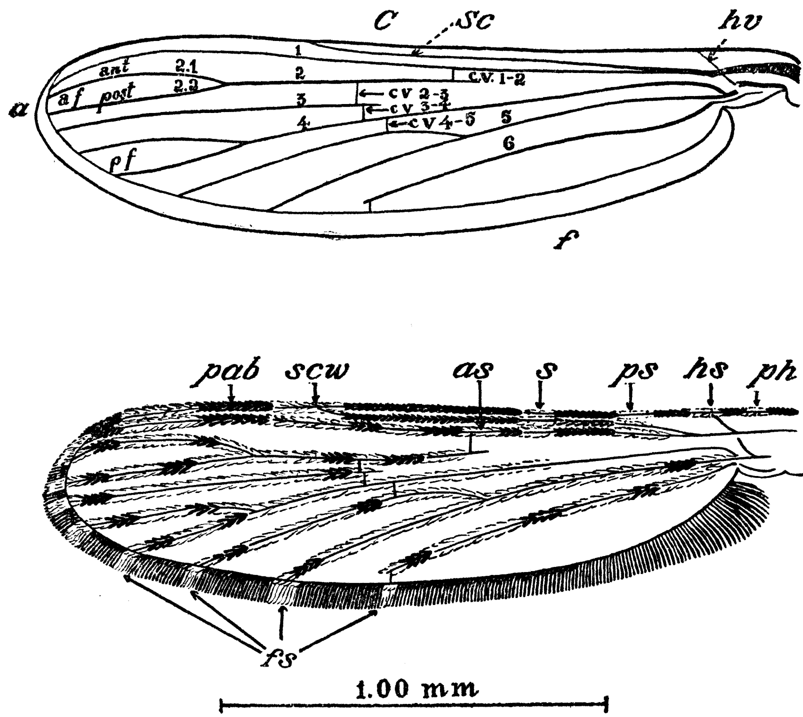

FIG. 3. *Anopheles maculatus* Theobald; wing; upper figure shows venation; lower figure shows ornamentation. *a*, Apex; *b*, base; *C*, costa; *Sc*, subcosta; *f*, fringe; *1* to *6*, longitudinal veins; *2.1*, anterior branch of second longitudinal vein; *2.2* posterior branch of second longitudinal vein; *cv*, crossveins; *hv*, humeral crossvein; *af*, anterior forked cell; *pf*, posterior forked cell; *ph*, prehumeral white spot; *hs*, humeral spot; *ps*, presector spot; *s*, sector spot; *as*, accessory sector spot; *pab*, preapical black spot; *scw*, subcostal white spot; *fs*, fringe spots. (Camera-lucida drawing, semidiagrammatic.)

The coloration or ornamentation of the wing is due to wing scales, the general arrangement of which is shown in the lower part of text fig. 3. The pale parts, whenever sufficiently compact and of such size as to be well demarcated from the surrounding dark portions, are usually referred to as "pale spots," "pale areas," or "pale patches;" the word "pale" being replaced with "dark" when reference is made to the dark parts on pale background or surrounding. Such a constantly pale area, however, as the subcostal pale spot, is merely called "subcostal spot." The markings on the male may be less vivid than those on the female.

F. THE LEGS

The legs of a mosquito are also important in the identification of species. The essential parts for this purpose are shown in text fig. 4. The coxa articulates with the thorax. Below the coxa come the trochanter, the femur, the tibia, and the tarsus in that order. The tarsus consists of five segments. The coxæ may or may not be devoid of scales, but the other segments are scaled (except occasionally the trochanters of the hind or middle legs). The femora may be pale at the trochanter end. Both the femora and the tibiæ may be pale at their distal ends. Such paleness constitutes what is sometimes called a "knee spot." The femora, tibiæ, and tarsi may have irregular rings of pale scaling, in which case they are sometimes referred to as being "speckled."

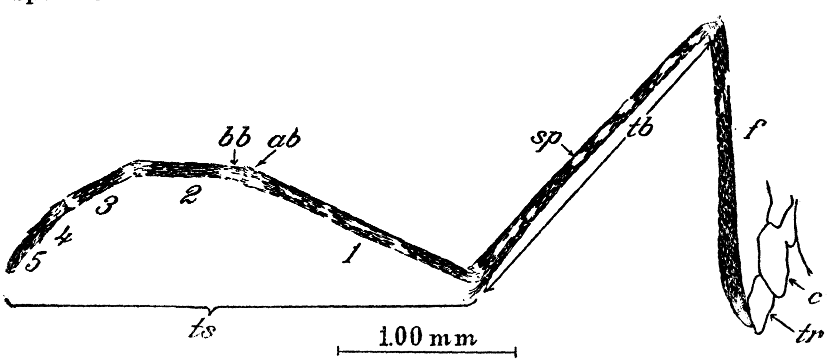

FIG. 4. *Anopheles maculatus* Theobald; foreleg; *c*, coxa; *tr*, trochanter; *f*, femur; *tb*; tibia; *ts*, tarsal segments; *ab*, apical band; *bb*, basal band. (Camera-lucida drawing, semidiagrammatic.)

The tarsal segments frequently carry the most useful ornamentation for diagnostic purposes. They may be entirely dark or they may carry pale bands. These bands may be only at the lower tips, in which case they are "apical," or they may be both "apical" and "basal," in which case they spread across the joints. Sometimes the last one, two, or three segments of the tarsus of the hind leg are completely white.

Each foreleg has a single large claw at its tip. The claw has a spur located midway and a smaller projection near the base. These processes are called the "male ungues" and are typical of all Anophelini, with minor variations. In both male and female the midlegs and hind legs are each provided with a pair of small hooks.

G. THE ABDOMEN

The scaling of the abdomen is sometimes useful in classifying Anophelini (text fig. 5). There are eight visible segments. The upper surface is usually called the "dorsum" and the dorsal portions of the segments are called tergites. The undersurface is the "ventrum," and the segments are "sternites." The male terminalia including segment VIII rotates 180° soon after emergence of the adult mosquito from the pupal cast so that the anatomically dorsal portion of these parts becomes ventral, and vice versa.

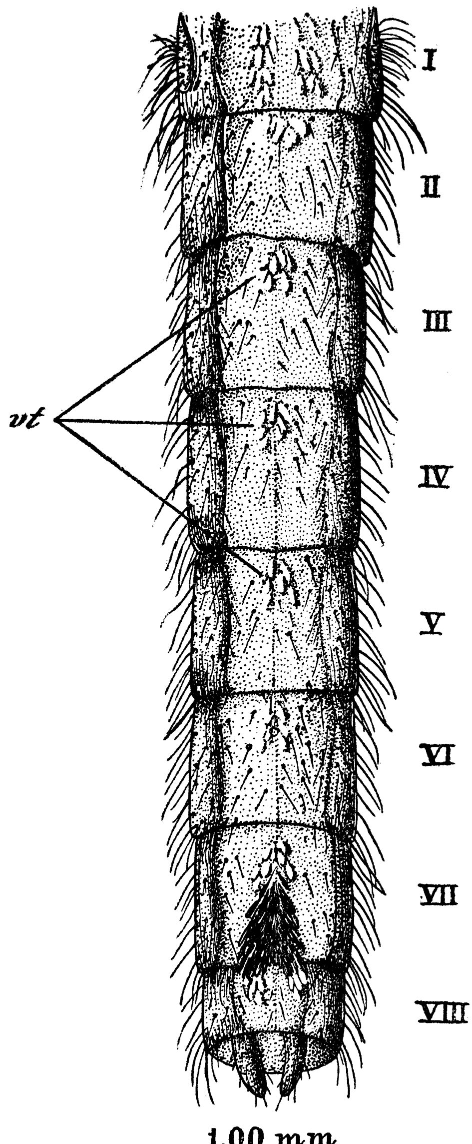

FIG. 5. ***Anopheles pseudobarbirostris*** **Ludlow; abdomen, segments I to VIII; *vt*, ventral tufts. (Camera-lucida drawing, semidiagrammatic.)**

H. THE HYPOPYGIUM, OR TERMINALIA

The terminal part of the abdomen beyond segment VIII is called the "hypopygium" or "terminalia." This structure in the male has important characters for identification purposes (text fig. 6). One should learn to recognize the following parts:

Proctiger, or anal lobe.—The anal lobe is largely membranous.

Coxites, or side pieces.—The coxites are conically cylindrical.

Styles, or claspers.—The styles are long processes attached to the coxites and terminating in small spurlike appendages.

Parabasal spines.—There are two of these spines on each side in the subgenus *Anopheles,* as a rule. In *Myzomyia* there are usually five smaller spines or hairs.

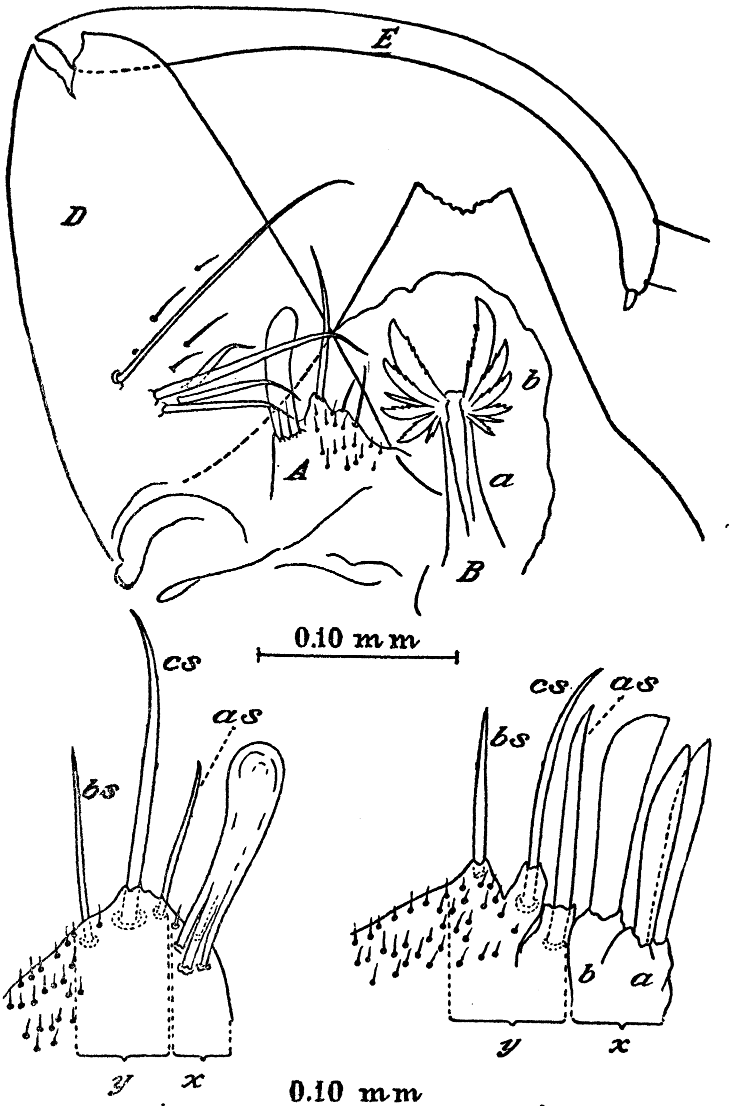

FIG. 6. Male terminalia; *Anopheles maculatus* Theobald, upper; harpago of *A. maculatus* Theo., lower left; harpago of *A. aitkeni* var. *bengalensis* Puri, lower right. *A*, harpago; *x*, dorsal lobe; *y*, ventral lobe; *a*, external; *b*, internal; *as*, external spine; *bs*, internal spine; *cs*, apical spine; *B*, phallosome; *a*, stem; *b*, leaflets; *D*, coxite; *E*, style. (Camera-lucida drawing, semidiagrammatic.)

Internal spines.—One or two spines on each side arise from the inner edge of the coxites.

Harpagos.—The harpagos are lobe-shaped processes, one on the inner side of each coxite near its base. In the subgenus *Myzomyia* the harpago is usually rounded or conical, clubbed dorsally, and has an "apical hair" and one or more smaller accessory hairs. In the subgenus *Anopheles* the crest of the harpago is frequently lobate, each lobe has short spines, and those on the dorsal lobe are fused into a clublike process. The harpago, following Christophers's (1933) latest designation of parts, has two lobes as follows:

The dorsal lobe of the harpago.—In *Anopheles aitkeni* var. *bengalensis* and in *A. insulæflorum* two parts may be distinguished; namely, the external, ventral lobe of Puri (1930), and the internal. Each bears much flattened spines. Those of the external part are usually not fused, but may sometimes be imperfectly fused apically either with each other or with those of the internal part. The internal part may bear one or two well-fused spines, much flattened and rounded like a club towards the apex. In all other species the parts representing the external and the internal portions are hard to distinguish. This is particularly true in subgenus *Myzomyia.* For purely diagnostic purposes, however, it is not necessary to differentiate the parts, except in the two species named above.

The ventral lobe of the harpago.—It is difficult to distinguish the demarcations between the parts of the ventral lobe even in *A. aitkeni* var. *bengalensis* and in *A. insulæflorum* in which they are supposed to be best shown. For simplicity and convenience we shall merely refer to the spines it bears as follows: The one on top of the prominence, typically the longest in all species except *insulæflorum,* the "apical spine;" the one or ones between it and those of the dorsal lobe, the "external spines," and the one or ones towards the inner side, the "internal spines" (text fig. 6).

The harpago varies a great deal in many species. The dorsal lobe (Christophers, 1933), except in *A. aitkeni* var. *bengalensis, gigas* var. *formosus, insulæflorum, lindesayi* var. *benguetensis,* and *pseudobarbirostris,* typically bears a club, which is a fusion of several flattened spines. In some individuals, however, the fusion is complete on one side and not on the other; in others the club is duplicated; and in still others there is a secondary club. Generally the spines of the ventral lobe follow a certain subgeneric, and sometimes specific, pattern. The apical spine may sometimes be branched or doubled; the inner spine

may be absent, in which case it is usually replaced by a mark; when present, it may be far removed from its usual position or more than the usual number may appear. Likewise, the external spine varies as to number, size, and length. Sometimes it is flattened like a blade; or else it may assume the form of a small club. *Anopheles philippinensis* seems to have the most variable harpago. In no two individuals we dissected were the harpagos alike, and in only one mosquito were they exactly alike on both sides.

Phallosome, or mesosome.—This single process lies between the two harpagos. Its apex may be bare; most frequently it has from three to more than ten leaflets extending from each side. These leaflets may or may not be serrated on one or both sides.

We have dissected as many male terminalia as our collections permit. To note variations we included in each species, whenever available, individuals from different islands and from different altitudes.

We realize that the average field worker may not be able to use the male terminalia in his routine identifications, so we have based our key on other characters wherever possible. Only in the case of *Anopheles aitkeni* var. *bengalensis* and *A. insulæflorum* has it been necessary to rely on the male characters. Fortunately these two species are not very common or important. We would recommend, however, that anyone seriously interested in *Anopheles* should try to learn how to mount and identify the male terminalia. The female hypopygium is not used in classification (Christophers, 1933).(8) Christophers also gives a good account of the technic of preparing mosquitoes for identification.

In the illustrations numbers and letters indicate structures as follows:

1, Palp.
2, Proboscis.
3, Mesonotum.
4, Wing.
5, Leg.
  a, Foreleg.
  b, Midleg.
  c, Hind leg.
6, Abdomen.
  a, Dorsal
  b, Ventral.

7, Terminalia.
  A, Harpago.
    x, Dorsal lobe.
      a, External part.
      b, Internal part.
    y, Ventral lobe.
      as, External spine.
      bs, Internal spine.
      cs, Apical spine.

7, Terminalia—Continued.
B, Phallosome.
a, Stem.
b, Leaflets.
C, Process of ninth segment.

7, Terminalia—Continued.
D, Coxite.
a, Expanded organ on side of coxite.
E, Style.

TECHNIC

The subject of technic requires so much consideration that we have prepared a separate paper on this subject.(14) Here we simply emphasize that mosquitoes are fragile and must be handled carefully. Rough treatment will cause important structures, such as hairs and scales, not to mention legs and wings, to rub off and thus may interfere seriously with identification.

LIST OF PHILIPPINE ANOPHELES

In our recently published key to larvæ of Philippine *Anopheles* we gave as complete a synoptic table of local anophelines as possible. Therefore, in this paper we shall merely give a list of the Philippine species as at present classified.

For lack of specimens from certain type localities, with which to compare our own, we use provisionally certain names. Thus we designate one of our species *insulæflorum,* although it seems to differ in at least one respect from the Indian species of that name. Christophers and others seem to indicate a similarity between the spines of the ventral lobes of the harpagos of *aitkeni* var. *bengalensis* and *insulæflorum;* at least, no difference in this structure between the two species has been mentioned or illustrated. In what we call *insulæflorum* in this paper, the spines on the ventral lobe of the harpago are much shorter and less flattened than those of var. *bengalensis.*

The value of direct comparison is obvious. The specimens of Indian *Anopheles barbirostris* and *maculatus* we received from Doctor Barraud illustrate the point we want to bring out. The female Indian *barbirostris* (two have the abdomen intact) shows very definitely the scattered white scales on the ventral aspect of the abdomen. These are even more conspicuous than the ventral white scale tufts of the Philippine *pseudobarbirostris.* We have not seen a single Philippine *barbirostris* of this type. In the few cases where the ventral scales are present, the scales are long, curved, and narrow, and yellowish in tinge rather than white. The Indian *maculatus* sent to us also bears very much more numerous and broader scales than any found in the Philippines. Abdominal tergite II as illustrated in Plate 24 will serve to show the contrast between the Philippine

and the Indian forms. This is only one of the forms found in India.

So, too, we cannot be certain about *A. baezai* Gater. The name is used merely for convenience and in accordance with the purpose for which this paper is intended.

Our list of Philippine *Anopheles* is as follows:

Tribe ANOPHELINI

Genus ANOPHELES

Subgenus ANOPHELES

1. *Anopheles aitkeni* var. *bengalensis* Puri, 1930.
2. *Anopheles gigas* var. *formosus* Ludlow, 1909.
3. *Anopheles insulæflorum* Swellengrebel and Swellengrebel de Graaf, 1920.
4. *Anopheles lindesayi* var. *benguetensis* King, 1931.
5. *Anopheles baezai* Gater, 1933 (?). Perhaps a variety of the true *baezai*, or else a distinct species.
6. *Anopheles barbirostris* van der Wulp, 1884.
7. *Anopheles hyrcanus* var. *nigerrimus* Giles, 1900.
8. *Anopheles hyrcanus* var. *sinensis* Wiedemann, 1828.
9. *Anopheles pseudobarbirostris* Ludlow, 1902.

Subgenus MYZOMYIA

10. *Anopheles kochi* Dönitz, 1901.
11. *Anopheles kolambuganensis* Baisas, 1931.
12. *Anopheles leucosphyrus* Dönitz, 1901.
13. *Anopheles tessellatus* Theobald, 1901.
14. *Anopheles filipinæ* Manalang, 1930.
15. *Anopheles mangyanus* Banks, 1907.
16. *Anopheles minimus* var. *flavirostris* Ludlow, 1914.
17. *Anopheles litoralis* King, 1932.
18. *Anopheles ludlowi* Theobald, 1903.
19. *Anopheles parangensis* Ludlow, 1914.
20. *Anopheles subpictus* var. *indefinitus* Ludlow, 1904.
21. *Anopheles vagus* var. *limosus* King, 1932.
22. *Anopheles annularis* van der Wulp, 1884. *Anopheles fuliginosus* Giles, 1900.
23. *Anopheles karwari* James, 1903.
24. *Anopheles maculatus* Theobald, 1901.
25. *Anopheles philippinensis* Ludlow, 1902.

We have included also three undetermined anophelines, as follows:

26. *Anopheles* of undetermined species or variety (?).

    From Balabac, Palawan, collected in 1933 by P. F. Russell and A. M. Nono. This form has lately been taken also in Iwahig, Palawan. It may prove to be a geographic variety of *leucosphyrus*.
27. *Anopheles* near-*leucosphyrus* King.

    Taken in Mindanao by F. E. Baisas and D. Santiago.
28. *Anopheles* belonging to *aitkeni* group.

    Taken on Mount Banahao, Luzon, by F. E. Baisas and D. Santiago. No adult is known.

DESCRIPTIVE NOTES

1. ANOPHELES AITKENI var. BENGALENSIS Puri, 1930. Plate 1.

Medium-sized, dark, *Culex*-like at rest.

Palpi of female slender, dark, slightly swollen apically. Palpi of male slender, dark, clubbed as usual. This club is light and shiny when devoid of scales. Normally, the scales do not entirely cover the club and the spaces between them give an effect of white patches under certain light.

Proboscis dark up to labella.

Wings entirely dark, with narrower scales than other species.

Legs slender and entirely dark.

Abdomen dark dorsally and ventrally; no scales even on cerci and coxites.

Male terminalia: Harpago with external portion (*a*) of dorsal lobe (ventral lobe of Christophers, 1915, and Puri, 1930) with two broad spines; the inner with a still broader spine, which in some appears to be a fusion of two spines. Phallosome devoid of leaflets and spinous processes.

2. ANOPHELES GIGAS var. FORMOSUS Ludlow, 1909. Plate 2.

Largest Philippine *Anopheles*. Pale in appearance because of wide yellowish areas on wing. Anopheline attitude at rest.

Palpi of female with tip of segment 5 pale; pale rings at joints 4–5, 3–4, and some pale scales at 2–3. Palpi of male with segment 2 dark, a wide pale band at 2–3; 3 dark subbasally up to about one-third or one-half, rest mainly pale up to apex, but appearing dark under certain light; 4 and 5 mainly pale, with indefinite dark patches at about middle or base.

Proboscis dark, except labella.

Wings broad, with conspicuous pale spots; costal spots long, especially presector and subcostal; sector and preapical spots absent; pale area at middle of vein 2.1 and fringe spot between 5.2 and 6 sometimes absent.

Legs with fore femora much lighter in hue than mid- and hind femora, all with few white scales at apices and conspicuous yellow band at bases. Tibiæ dark with pale apices, apex of hind tibia more conspicuous; hind tibia with a distinct yellow spot at base on underside, appearing like a subbasal spot when viewed laterally. Fore tarsi with apical bands on 1 and 2 and often 3; pale basal bands on 1, 2, 3, and, usually, 5; midtibia with pale patches on apices of 1, 2, 3, and, less often, 4; hind tibia with more or less distinct apical and basal bands on 1 to 4; 5 often with a pale patch basally.

Abdomen pale and devoid of scales, even on cerci, but coxites with numerous long and broad scales along external borders.

Male terminalia: Process of segment IX very vestigial, unlike those of other species of this subgenus. External portion of dorsal lobe of harpago with three or four flattened spines; internal portion with one flattened spine longer than those of the external; ventral lobe with three spines, the apical the longest and sometimes duplicated; usually two external spines, one of which may be very short or absent; no internal spines. Phallosome with five to seven, relatively narrow, serrated leaflets on each side.

3. **ANOPHELES INSULÆFLORUM Swellengrebel and Swellengrebel de Graaf, 1920. Plate 3.**

Merium-sized, dark, *Culex*-like at rest. Indistinguishable from *aitkeni* var. *bengalensis* except by larval and genitalic characters. (Both species are uncommon. They may sometimes be found in the same forest stream, but as a rule *aitkeni* prefers the upper parts of the streams. We have not taken them from the same place.)

Male terminalia: The male of *insulæflorum* is easily differentiated from that of *bengalensis* by the spicular processes on the phallosome and also by the spines of the ventral lobe of the harpago. Dorsal lobe of harpago externally bears two or three flattened spines which in Philippine specimens tend to assume various forms. In one specimen they are fused apically with the internal spines. Internally the dorsal lobe bears a much-flattened clublike process. Ventral lobe with external spine much shorter than club; often narrower, and much shorter than that of *bengalensis*. Middle still shorter; internal longer than external but shorter than club.

4. **ANOPHELES LINDESAYI var. BENGUETENSIS King, 1931. Plate 4.**

Fairly large and dark. Peculiar in having a broad white band at about the middle of hind femur.

Palpi entirely dark.

Proboscis dark.

Wings extensively dark; costa, subcosta, and vein 1 dark except for apical pale spot; pale spots at tips of veins 4.2, 5.2, and 6; usually pale fringe spots opposite apices of these veins, but not always.

Legs with fore and midfemora white-ringed at bases; hind femora with wider but variable pale area dorsally and ven-

trally; a conspicuous white band near middle. Tarsi with all segments dark.

Abdomen dark, devoid of scales even on cerci, but some present on external borders of coxites.

Male terminalia: Dorsal lobe of harpago with three unfused broad spines, broadest toward apices; ventral lobe with apical spine longer than club; one internal spine, about as long as club or longer; no external spine. Phallosome with eighteen or nineteen narrow leaflets on each side, some with serrations, and one or two cleft at apices.

5. **ANOPHELES BAEZAI** Gater, 1933. Plate 5.

Fairly large and dark. Anopheline attitude, but not so marked as in *A. barbirostris*. (Reported southward from Camarines Norte to Mindanao and Palawan. Formerly locally reported as *umbrosus*. In a personal communication, Gater, after examining some of our specimens, writes that it may be a variant which he has referred to as "Form A." According to him the *umbrosus* group is still very confused. Certainly the species we are describing is not typical *umbrosus*, and until the present species *baezai* is further divided we prefer to use the name *baezai*.

Palpi shaggy and entirely dark.

Proboscis dark, except for labella.

Head with vertical tuft and anterior vertex white; rest of head black-scaled.

Thorax dark; mesonotum devoid of scales except for a few narrow dark ones at the anterior border; pleura without scales. *Apl* with a group of broad flat scales on upper portion, and scattered bristles all over. Propleural hairs present.

Wings mostly dark anteriorly; costa entirely dark except for the subcostal and subapical pale spots. The subcostal spot does not involve vein 1 in the female but involves the anterior side of that vein in the male. The preapical spot involves the apex of vein 1 and continues to vein 2.1, where it forms a subapical pale area. Aside from an apical white spot, vein 1 has a few white scales or a complete pale patch near the origin of vein 2. Vein 2.2 dark with a subbasal pale area; stem of 2 usually with two dark patches towards the basal two-thirds, which are sometimes contiguous, the rest with an admixture of black and white scales. Vein 3 with a basal black area, remaining portion pale with scattered black scales on lateral squames. Vein 4.1 pale with a few black scales near point of origin; 4.2 with apex and

base black. Vein 5.1 with apical and subbasal dark patches, the rest often with scattered black scales. One or two dark scales may be present at point of bifurcation. Vein 5.2 black apically, pale towards base which at times has scattered black scales. Stem mostly black towards base; whitish towards apex. Vein 6 with apical and middle black areas, the base entirely pale. Only one fringe spot, situated at apex of 2.2, continuous to opposite 3. Fringe opposite 1–2.1 dark. Humeral crossvein with some dark scales. Remigium entirely dark-scaled. The wing marking of the male varies somewhat from that of the female due to more scanty scales and more liberal distribution of pale ones.

Legs entirely dark with some white scales at the apices of femora and tibiæ, and sometimes one or two pale ones at the apices of some of the tarsal segments.

Abdomen black dorsally and ventrally without scales even on cerci, but coxites with long scales along the external borders.

Male terminalia with process of segment IX developed, but not as long as that of *hyrcanus.* Dorsal lobe of harpago carries a club; ventral lobe with the apical spine much longer than the club; external spine shorter than the apical but longer than the club; no internal spines. Phallosome normal, with fairly long, broad, usually unserrated leaflets; five to six leaflets of uniformly decreasing size on either side.

6. **ANOPHELES BARBIROSTRIS** van der Wulp, 1884. Plate 6.

Large and black, with distinctly anopheline attitude. Of all *Anopheles* it forms the greatest angle with the surface on which it rests.

Palpi of female shaggy and entirely dark. Palpi of male black with an apical white ring on outward aspect on segments 3 and 4. No specimen we have examined has had the ring absent on 4 and only rarely on 3. In *barbirostris,* as in some other species, the male palps show different hues when viewed at different angles under the same light. The predominating one in various positions is considered the true character.

Proboscis entirely dark, except labella.

Wings with an admixture of pure white and black scales; black scales on humeral vein. Unlike *baezai,* the basal third of the costa together with that portion under it of the subcosta and of vein 1 have scattered pale scales; and one, two, or several pale scales often interrupt the continuity of black on the humeral and prehumeral areas of costa. Apical white involves tip of veins 1 and 2.1. Vein 2.2 has white preapical pale area (some-

times purely pale, sometimes with scattered black scales) aside from a subbasal pale patch. Fringe spots opposite apices of 2.1 and 3 and usually opposite 5.2. That opposite 3 may extend to opposite 4.1. Again, unlike *baezai, barbirostris* has the stem of 2 entirely black and there are scattered black scales at the basal portion of 6. Remigium covered with dark and pale scales; the pale scales sometimes covering basal part, sometimes in a cluster at the middle, or merely scattered among the dark scales. Less obvious differences are shown on Plates 5 and 6.

Legs with the femora dark above, pale beneath towards the base; an indefinite pale ring at the base. Tibiæ with some pale scales at the apices. Fore tarsi dark, with narrow pale rings on apices of 1 and 2 and sometimes also on 3; midtarsi with a few pale scales on apices of 1 and 2; hind tarsi with narrow pale rings at apices of 1 to 4.

Abdomen dark; tergites devoid of scales; sternites usually also without scales except on VIII of males and VII of females where a tuft of scales is present. In males, segment VIII together with the terminalia has been rotated 180° so that the tuft appears to be on the dorsal aspect. In females the tuft is usually composed entirely of dark scales, but a few pale scales may be found mixed with them. Sometimes a few narrow yellowish scales are present on some other sternites, but they are never as conspicuous or numerous as those found in *barbirostris* from India. Female cerci devoid of scales; male coxites with many scales along external borders.

Male terminalia with the process of segment IX developed as in *baezai*. Dorsal lobe of harpago carries a club, invariably well fused; ventral lobe with apical spine much longer than club; external spine a little shorter than apical and longer than club. Phallosome with four or five, rarely six, long leaflets on each side; three or more, including the longest, are serrated on both sides, the rest on one side only.

7. ANOPHELES HYRCANUS var. NIGERRIMUS Giles, 1900. Plate 7.

Fairly large and dark with markedly anopheline attitude at rest. Noticeable because of its size and conspicuous banding of legs.

Palpi of female shaggy; black, with some scattered pale scales, aside from the rings at 2–3, 3–4, and 4–5; base and apex of 5 pale, forming subapical (4–5) and apical rings, respectively. Palpi of male with a line of white scales on the upper surface, usually running throughout entire length of 2,

its apex being white; 3 with scattered white scales, and white at apex; basal two-thirds or more of 4 light or golden (very deceptive when viewed at different angles under the same light), with a subapical dark and an apical white ring; 5 all white except outer margin and usually a narrow dark area at base.

Proboscis dark, except labella.

Wings differ from those of *barbirostris* as follows: Pale fringe spot at tip of wing involves area opposite 2.1, 2.2 to 3; subapical pale costal spot does not involve extreme tips of veins 1 and 2.1; pale scales on basal third of vein 1 and subcosta well scattered and intermixed with the dark ones, unlike those of *barbirostris* in which the pale scales are in clusters forming bandlike interruptions on the line of dark scales; moreover, the scales on this portion of the wing are closely appressed to the veins, and the individual scales are narrower than those of *barbirostris,* which are more expanded and not closely appressed to the veins. In *nigerrimus* there are no scattered dark scales between the dark patches at the apex of vein 5.2 and at the base of its stem; the humeral crossvein is bare, and the remigium has a continuous line of pale scales on the anterior border, but entirely dark or with pale interruptions at the posterior border; sometimes the whole remigium is entirely pale excepting for 1 or 2 dark scales. Fringe spot opposite 5.2 rarely present.

Legs with femore dark, pale beneath (except fore femora, which are pale only towards apices), somewhat posteriorly with some pale scales at apices. Tibiæ dark, often pale beneath. Tarsal segments with white bandings variable in size, but always conspicuous enough for the naked eye. (Numerous specimens caught in Luzon, Mindanao, and Palawan have bandings sufficiently marked for macroscopic recognition.) For tarsi and midtarsi with 1 to 3 widely banded apically; 4 with a narrow ring or a mere pale patch. Hind tarsi, 1 with a narrow apical ring; 2 and 3 broadly banded apically; 4 with both basal and apical bands; 5 banded basally, the extent of white varying from a very narrow ring to half the length of this segment. Sometimes segment 3 has also a basal band.

Male terminalia with the process of segment IX developed and long. Harpago with dorsal lobe carrying a club; not completely fused at times; ventral lobe with apical and external spines longer than club, the apical longer than external. Phallosome leaflets usually five on either side, but may be more or less, a few specimens showing eight, inclusive of the fine spines;

leaflets rather small, the broadest one, and often also the next broadest, with one or two coarse teeth near the apex, forming a peculiar pattern.

This is particularly true of those collected in Cotabato, Mindanao. Those from Luzon have smaller teeth, and on one side of a specimen there are no teeth at all (Plates 7 and 8). The difference indicated by Baisas(5) between the leaflets of *nigerrimus* and *sinensis* is substantiated by our present work, so that for the Philippines at least this may be useful.

Doctor Barraud sent us some adults (all females, apparently caught wild and not bred out) labeled *nigerrimus*. In nine of these, which have the hind legs in good condition, the white markings vary considerably, one showing basal as well as apical banding on hind tarsal segments 3 and 4; five others show the basal band on 4 in varying degree; four have basal banding on 5, in one case covering half of the segment and in another having but a trace of it.

8. ANOPHELES HYRCANUS var. SINENSIS Wiedemann, 1828. Plate 8.

Much like *nigerrimus*, although often somewhat lighter in hue, and smaller. (Those from Baguio are larger generally than those from the lowlands, and are about as dark as *nigerrimus*.)

Palpi of female banded like those of *nigerrimus*, those of Baguio specimens generally better marked than those of lowland specimens; the extent of banding is, however, very variable. Palpi of male like those of *nigerrimus;* males from Baguio usually have a wider basal black patch on 5.

Proboscis dark, except labella.

Wings very similar to, but in general having more scattered pale scales than, those of *nigerrimus;* subcostal spot usually conspicuous and involving the whole or part of vein 1. Specimens from Baguio have comparatively smaller subcostal spot, which in a few cases does not involve vein 1 at all; there are also fewer scattered pale scales elsewhere on the wing veins. Specimens from the lowlands frequently have a distinct pale spot on vein 1 near the origin of vein 2, and less often another spot a little basal to the subcostal spot. Fringe spot opposite 5.2 rarely present; basal black area on vein 5 invariably large. Remigium usually mainly dark-scaled, with a little admixture of pale scales, the anterior border being continuously pale in only a few individuals from Baguio, and pale on apical half and dark on basal part in a few from the lowlands.

Legs with considerably narrower bands than those of *nigerrimus;* none have a basal ring on hind-tarsal segment 4.

Abdomen similar to that of *nigerrimus.*

Male terminalia with process of segment IX developed. Dorsal lobe of harpago carries a club, sometimes imperfectly fused; ventral lobe with apical and external spines longer than club, apical spine longer than external. Phallosome usually with five leaflets on either side, most of which are serrated from near the base upwards on one side, and the largest also serrated near the apex on the other side. One of two male *sinensis* from Hongkong, sent to us by Doctor Jackson, has fewer and coarser serrations on the phallosomal leaflets (Plate 8), but the other approaches the type of Philippine forms.

9. ANOPHELES PSEUDOBARBIROSTRIS Ludlow, 1902. Plate 9.

Large and black; much like *barbirostris* in its anopheline attitude at rest.

Palpi of female shaggy and entirely dark. Palpi of male dark, with pale rings at 2–3, 3–4, and 4–5.

Proboscis dark, including labella.

Wings usually with a fringe spot opposite 5.2; otherwise very similar to wings of *barbirostris.* The fringe spot opposite 4.1, like that of *barbirostris,* varies in size; it may be formed by three or four pale fringe scales or may extend to the edge opposite 3. A narrow fringe spot opposite 4.2 is very rarely present, but we found no individual with a fringe spot opposite 5.1. Humeral crossvein with dark scales. Remigium mainly dark-scaled with about two pale scales at the middle.

Legs dark with scattered white scales on femora and tibiæ, especially numerous on underside of fore femora; pale apices on most of tarsal segments; fifth hind-tarsal segment often has a narrow pale basal ring.

Abdominal tergites dark, devoid of scales; upper surface (really ventral) of VIII in male with some pale scales at about the middle; sternites with white scale tufts on II to VII; that on VII followed by a large black tuft towards posterior border; VIII in female with two distinct groups of white scales, one on either side near the median area. In dried specimens these white scales appear to be part of scale tuft VII, as segment VIII is telescoped into VII. In females, less so in males, there are numerous white scales on the depressed area on either side of the median line on II and a few scattered ones on the other segments (dried specimen).

Male terminalia with process of segment IX like that of *barbirostris*. Harpago with dorsal lobe projecting prominently; carries two to four, usually three, unfused, flattened, somewhat curved, lanceolate spines; ventral lobe with apical and external spines longer than club, the apical longer than external. Sometimes there is a short extra spine between the two spines. Phallosome with two unserrated leaflets, each having a prominent basal tooth; one specimen has three leaflets on one side (Plate 9).

10. ANOPHELES KOCHI Dönitz, 1901. Plate 10.

Medium-sized, rather light (or fawn) colored, with conspicuous hind-tarsal bands. Anopheline attitude at rest.

Palpi of female with some pale scales at middle of outer surface of 2; pale band at 2–3; 3 dark at base and middle, with an intervening subbasal wide pale area; white apically; 4 black at base, golden at middle, and white at apex; 5 dark at base, apical two-thirds golden. Palpi of male with a wide golden area at middle of 2, black basally and apically; unscaled pale area 2–3; 3 black at base followed by wide yellow, and then a dark band; a subapical wide yellow band, the apex black; 4 entirely golden, except sometimes a white patch at base, wide subapical narrow white and apical narrow black bands; 5 entirely golden. Proboscis with apical half golden, a narrow ring or patch of black at apex of labium; basal half dark with golden spots or scattered golden scales.

Wings extensively pale, accessory sector spots forming a wide pale area even in the costa, particularly in female; vein 6 with three dark spots in female, often only two in male; fringe spots opposite apices of all veins and between the forks of 5, and 5.2 and 6.

Legs spotted; fore-tarsal segments 2 and 3 with wide white apical and basal patches on anterior surface, seldom forming complete bands around segment; a similar patch on apex of 1 and on base of 4; apex of 4 often entirely dark, occasionally with a tiny pale patch; midtarsi with narrow pale patches at joints of 1–2, 2–3, and 3–4; hind-tarsal segment 1 with narrow apical ring; 2 with wide apical band, but none on base; others all broadly white-banded apically and basally.

Dorsum of abdomen with narrow golden scales from II to VIII; sometimes a few also on I; the scales mostly towards apex of each segment, becoming more numerous towards posterior segments; ventrally black scale tufts from II to VII. Numerous yellow scales on cerci of females and on coxites of males.

Male terminalia: Dorsal lobe of harpago with a club; ventral with an apical spine a little longer than club; one or two internal slender spines; no external spine. Phallosome short, leaflets small, with few serrations; from six to eight leaflets on either side.

11. ANOPHELES KOLAMBUGANENSIS Baisas, 1931. Plate 11.

Medium-sized, rather pale.

Palpi of female with some white scales at midouter surface of 2; white scales at apex form narrow band on 2–3; 3 with basal half dark, followed by a wide white area and a narrow black area, extreme apex golden; basal third of 4 dark, the rest upwards golden or whitish; base of 5 usually dark, the apex golden; but sometimes this segment is entirely golden. Palpi of male with more numerous white scales at middle and base of 2; narrow pale band at 2–3; a middle indefinite wide pale area on 3, followed by a black and a pale band; enlarged portion at the apex black; segment 4 entirely golden, white under certain light; 5 also golden except for a dark basal band.

Proboscis dark, except labella; usually with a pale golden subapical band or patch.

Wings extensively pale; prehumeral area usually pale on basal two-thirds; at times with a dark interruption, thus forming a prehumeral white spot. All other costal spots are wide, with the exception of the sector white area, which in rare instances is tiny. The accessory sector spot is particularly conspicuous in this species, and involves the costa completely. The black area between sector and accessory sector spots is represented by a mere dot on the costa. Black area between preapical costal and subcostal spots frequently divided into two, always so on vein 1, and very rarely continuous on costa; black spots on stem of 2 and 4.1 may be two or three. Pale fringe spots opposite all veins are so wide as to encroach upon, or entirely obliterate, the black areas, particularly opposite the first two veins. The greater part of fringe basal to opposite vein 6 is, also pale.

Legs spotted, most of the tarsal segments with pale apical patches, some with basal pale patches also; tarsal segments often extensively pale.

Thorax with numerous broad pale scales on dorsum and sides, including sides and fossæ of mesonotum, decreasing in number and becoming absent in the middle in front of scutellum; pleura without scales. Anterior pronotal lobe with a tuft of scales.

Abdominal tergites with broad pale scales towards apices and sides from II to VII, the scales increasing in number and becoming mixed with black ones to form distinct lateral scale tufts on posterior segments, particularly on V to VII; VIII with numerous golden scales above, and both pale and dark scales beneath; ventrally, some pale scales toward lateroapical edges from II to VII; male like female, although with fewer scales on mesonotum and abdomen.

Male terminalia with parabasal spines of the *Myzomyia* type, somewhat similar to *kochi* in having spine 4 quite far from the basal group 1–3. The distance is not so great as in *kochi*. Dorsal lobe of harpago with a club, ventral lobe with apical spine longer than club; one slender internal spine, no external spine. Phallosome with six or seven leaflets, the largest well serrated on one side.

12. ANOPHELES LEUCOSPHYRUS Dönitz, 1901. Plate 12.

Medium-sized, highly spotted, with conspicuous band on tibiotarsal joint of hind leg.

Palpi of female dark with bands at 2–3, 3–4, and 4–5, the apical half of 5 pale. Some pale scales may be present at about middle of 2. Segment 2 of male palpi dark, with a variable amount of pale area in the middle; pale at 2–3; segment 3 dark, with a variable wide pale area in the middle, having a subapical golden, and an apical black, band; 4 entirely golden; 5 golden with a black basal band.

Proboscis dark, except labella.

Wings highly spotted, the extent and number of dark areas variable; vein 6 as well as others with many dark spots resembling only *tessellatus*. Fringe spots present usually up to 5.2; extra ones between apices of 5.1 and 5.2, and 5.2 and 6; none opposite 6 and sometimes also none opposite 5.2. (For other details see discussion below.)

Legs spotted. (See discussion below.)

Abdomen with black ventral scale tuft on VIII.

Male terminalia. (See discussion below and Plate 12.)

Discussion.—In the Philippines there are several types of this mosquito. We can recognize at least two distinct species, one of which seems to split into two forms. We shall designate the type found in Luzon and Mindanao as true *leucosphyrus;* that from Iwahig and Balabac, Palawan, as the Balabac variety; and that from rock holes (Mindanao) as near-*leucosphyrus*.

Near-*leucosphyrus* was first found by Mr. D. Santiago in 1930. The temporary name "near-*leucosphyrus*" was suggested by Dr. W. V. King, to whom the 1930 specimens were given. *Anopheles* near-*leucosphyrus* is undoubtedly a distinct species. Its larva differs from those of the other forms, while its adult shows some characters that readily separate it from the rest. The form found in Luzon and Mindanao runs closest to the *leucosphyrus* described in other countries by Christophers and others, while that found in Iwahig and Balabac, Palawan, varies somewhat from the Luzon type, both in larval and in adult forms. *Anopheles* near-*leucosphyrus* is smallest in average size, while collections from Iwahig show the largest individuals.

The posterior petiole index of near-*leucosphyrus* is remarkably different from all others, being considerably larger. The other indices for this form are also higher. By the anterior cell index the Balabac variety can be separated from the others. The males in all forms have higher indices than the females. In the position of the bases of the forked cells, the different forms also differ. Thus, in true *leucosphyrus* (Luzon and Mindanao) the base of the posterior forked cell is often nearer the wing base (sometimes in line with it, but never distinctly farther away) than that of the anterior forked cell. This seems to be true also in the illustration given by Christophers.(8, p. 178) *Anopheles* near-*leucosphyrus* has the base of the posterior cell distinctly farther away from the wing base than that of the anterior. The Balabac variety is often also like this, but may have the two bases in line with one another, the posterior not found nearer the wing base, however.

The wing markings are very much alike, varying in the dark areas in much the same way. In the case of the prehumeral pale spot, true *leucosphyrus* has it distinct, in the Balabac variety it is often tiny or lacking, and in near-*leucosphyrus* it is usually very tiny or lacking.

One of us (F. E. B.) is preparing a paper on this group, which will include the measurements for the various indices referred to above.

The conspicuous tibiotarsal band is about the same in all. The fore-tarsal bandings involve usually only the anterior surface of the legs of both *leucosphyrus* and near-*leucosphyrus;* the patches on the former, however, are larger and more distinct. In the Balabac variety the bands are often complete.

The Balabac variety is peculiar in having a white patch or complete band at the base of the fourth hind-tarsal segment. This may, in very rare cases, be absent in one of the legs of an individual, but it is not found absent in both. The hind-tarsal bands of this variety are also more conspicuous.

In the male genital characters, near-*leucosphyrus* is easily differentiated in having the smallest and least-serrated phallosomal leaflets. True *leucosphyrus* has usually fewer leaflets than the Balabac variety. The harpago normally has the same number of hairs as in the others.

13. ANOPHELES TESSELLATUS Theobald, 1901. Plate 13.

A medium-sized, highly spotted mosquito.

Palpi of female with a patch of pale scales at about middle of 2 and at about the middle of outer surface of dark basal band in 3; pale ring at 2–3, almost apical half of 3 white, base of 4 black, remaining three-fourths to apex white; base of 5 black, remaining portion golden or pale. Palpi of male with a patch of pale scales near base of 2, or a row of pale scales running the entire length of this segment in some individuals; pale bands at 2–3; 3 with a dark basal band, a large pale patch at middle, followed by a white band, and an apical dark ring; 4 and 5 white, except for basal bands and dark area on outer side.

Proboscis with apical half, together with labella, golden in female, not in male; a subapical dark patch on female proboscis.

Wings much like those of *leucosphyrus* with the addition of a pale fringe spot opposite apex of vein 6, and more extensive border scales. A long dark area is sometimes formed on 6 by the fusion of several small dark spots.

Legs spotted, the dark and white well contrasted; tiny pale patches at apices of femora and tibiæ; fore tarsi with pale apical rings on 1–4; basal rings 2–4 in female, in male usually absent; narrow apical ring on 1–4 of midtarsi; not so definite in male; narrow apical rings 1–4 on hind tarsi in both sexes.

Abdomen with tergites and sternites dark and devoid of scales.

Male terminalia: Dorsal lobe of harpago with a club; ventral lobe with apical spine longer than the club; one or two, slender, internal spines rarely present; no external spine. Phallosome with seven to ten leaflets on either side; in specimens from Luzon the leaflets tend to be less serrated than in those from Mindanao.

14. ANOPHELES FILIPINÆ Manalang, 1930. Plate 14.

A small dark mosquito, anopheline in attitude. Palpi of female dark; narrow pale ring at 2–3; a pale band of variable width at 3–4; apical white of 4 together with 5, which is completely white, forms apical band; the black band at middle of 4 varies in width. Palpi of male with apex of 3 white; 4 and 5 black at base and outer edges; rest white.

Proboscis dark, except labella.

Wings with costal pale spots, though smaller than usual, of the *Myzomyia* type; the humeral spot may be absent or indistinct; the forks of 2 may be entirely black or else interrupted at about the middle with pale areas; typically vein 6 has three dark areas and a pale fringe spot opposite its apex.

Legs dark; femora and tibiæ all dark, the apices indistinctly pale if at all. Fore tarsi with segment 1 usually having a fairly conspicuous band or patch; 2 less so; 3 still less or not at all; 4 and 5 entirely dark; midtarsi with segment 1 often banded, the rest dark; hind tarsi with segment 1 often banded; the rest entirely dark.

Abdomen dark, devoid of scales even on cerci; coxites with scales on the outer border.

Male terminalia: Dorsal lobe of harpago with a club; sometimes two clubs; ventral lobe with apical spine longer than club, sometimes branched; one or two external spines, longer than club but shorter than apical spine. Phallosome usually with five serrated leaflets on either side.

15. ANOPHELES MANGYANUS Banks, 1907. Plate 15.

Small, dark.

Palpi of female dark with pale bands at 2–3; apical white of 3 and basal white of 4 form wide subapical band; subapical dark band (variable in extent or entirely absent at times) formed at about middle of 4; apical white band of 4 together with segment 5, which is entirely white, form the apical band. Palpi of male with no pale band at 2–3; apex of 3 white; about basal half of 4, continuous to outer edge, black; base of 5 black; rest white.

Proboscis entirely dark, except labella.

Wings with humeral and presector costal spots well marked; veins 2.1 and 2.2 entirely dark, but 4.1 usually with a pale interruption at the middle; vein 6 usually with two dark areas,

the apical occupying about half of the vein; fringe spot opposite all veins except 6, which may rarely also have a spot.

Legs dark, without any definite white patch or ring on tarsal segments.

Abdomen dark, no scales on tergites, sternites, or cerci; but the coxites have scaling.

Male terminalia: Dorsal lobe of harpago with a club, sometimes incompletely fused; or one spine may be totally separated; ventral lobe with apical spine longer than club; external spine shorter than apical, but longer than club; one or two, slender, internal spines, about as long as external. Phallosome usually with five leaflets on either side, the largest ones serrated on one side.

16. ANOPHELES MINIMUS var. FLAVIROSTRIS Ludlow, 1914. Plate 16.

Small and dark, with anopheline attitude at rest.

Palpi of female and male resemble those in *A. mangyanus.*

Proboscis dark, with distinct flavescent area on ventral and lateral sides of apical half in female, often absent in male.

Wings very similar to wings of *mangyanus* except for absence or minuteness of humeral pale spot, and often also presector pale spot; vein 6 may be entirely dark except extreme base, and a pale fringe spot sometimes present opposite its apex.

Legs resemble those of *A. mangyanus,* although sometimes lighter in hue, and may have traces of paleness at apices of some tarsal segments.

Abdomen including cerci devoid of scales; coxites with scales.

Male terminalia: Dorsal lobe of harpago with a club; apical spine of ventral lobe longer than club; external spine a little shorter than apical, longer than club; internal spine one (rarely two), slender, always present. Phallosome with about five leaflets on either side, the largest ones serrated.

17. ANOPHELES LITORALIS King, 1932. Plate 17.

Medium-sized, brownish, with anopheline attitude at rest.

Palpi of female banded at 2–3 and 3–4; basal half of 4 dark, the apical white forming a continuous wide white apical band with 5, which is entirely pale. Palpi of male with a pale ring at 2–3; basal third of 3 black, followed by a mainly white area upwards to black subapical band, the apex white-ringed; segment 4 dark at base and along outer edge, white at middle towards apex and inner side; 5 with a black band at base and towards outer side where black area of the preceding segment somewhat

expands and merges with it, the black sometimes continuing towards the apex.

Proboscis dark, except labella.

Thorax with fossa of mesonotum having from two to four flat scales in male, and six to over ten in female.

Wings with costal sector spot often absent or indistinct in females; prominent in males; usually with white scales on prehumeral dark area, sometimes forming a complete prehumeral pale spot; in some specimens from Mindanao the basal part of the prehumeral costal area is entirely pale-scaled; no dark scales at origin of forks of 2 and frequently only two dark areas on vein 1 under midcostal black (Plate 17).

Legs spotted, mostly pale-scaled beneath, particularly mid- and hind femora and tibiæ as well as the fore-tarsal segments; apical and basal bands on most of the tarsal segments.

Abdomen with broad scales ventrally on VII, and few narrower ones on VIII; cerci with numerous broad scales.

Male terminalia: Dorsal lobe of harpago with a club; in one specimen there is a subsidiary smaller club; ventral lobe with apical spine, very much longer than club, somewhat flattened; one or two short, sometimes flattened, external spines; one or two internal spines longer than external, sometimes none. Phallosome with eight to fourteen serrated leaflets on either side, not markedly contrasted in length except the basal short ones.

18. **ANOPHELES LUDLOWI Theobald, 1903. Plate 18.**

Similar to *litoralis.*

Palpi very similar to those of *litoralis,* except that some females have black scales at the base of segment 5 forming an extra band; and in many males the basal dark area on 4 and 5 does not form a complete band.

Proboscis dark, except labella.

Thorax with fossa of mesonotum devoid of broad scales in male, usually also in female; rarely there are two or more scales in the female, which are, however, not as broad as those in *litoralis.*

Wings much as in *litoralis;* but the costal sector spot is complete and distinct, and there are no white scales on prehumeral dark area, but dark scales may be present at apex of stem of vein 2 immediately below the origin of 2.1–2.2.

Legs spotted, the spots more numerous and better defined and contrasted than those of *litoralis;* femora and tibiæ and tarsal segments largely dark-scaled; fore-tarsal segments 2 and 3 apically and basally banded, 1 with apical and 4 with basal band

only; 5 entirely dark; mid- and hind tarsi frequently without any basal bands.

Abdomen with some scales ventrally on VII and VIII; cerci with many broad scales.

Male terminalia: Dorsal lobe of harpago with a club; ventral lobe with apical spine much longer than club; external spine short; internal spine lacking. Phallosome with about five serrated leaflets on either side; the largest one somewhat S-shaped. In one specimen the largest on one side is not serrated.

19. **ANOPHELES PARANGENSIS** Ludlow, 1914. Plate 19.

A rare species; originally reported from Parang, Cotabato (1914); later found in Oriental Misamis (King, 1931); and in Davao Penal Colony (Nono, 1935), all in Mindanao Island.

The description and illustrations given here are from specmens kindly furnished by Mr. Andres Nono, formerly of Malaria Investigations, and now field director of the malaria control work of the Bureau of Prisons at Iwahig and Davao Penal Colonies.

Externally much like *ludlowi,* from which it differs in certain details of wing markings and leg spots.

Palpi of the female similar to those of *ludlowi,* the subapical dark band varying in width from a little less than half to about three-fourths of the apical white band. Palpi of the male also similar to those of *ludlowi,* but the preapical white on segment 3 (below the club) is much narrower.

Proboscis dark, except the labella.

Wings differ from those of *ludlowi* in having three dark spots on vein 6; two dark spots on vein 1 under the midcostal dark area; smaller subapical dark costal spot; extra pale fringe spot between the apices of the forks of vein 5, which may sometimes be fused with the pale fringe spot opposite 5.2; more extensive pale areas on fringe. Moreover, the accessory sector spot on subcosta and vein 1 is prominent and sometimes encroaches on the costa so that the midcostal dark area is broken in two; the outer accessory dark spot is sometimes so tiny as to be almost wanting; no dark scales at the forking of vein 2.

Legs more highly spotted than either those of *ludlowi* or of *litoralis,* the pale scales forming definite intermediate bands on some of the segments; wide apical and basal bands on fore tarsi.

Male terminalia: Phallosome with short, modified leaflets, and a membranous process at apex. Parabasal spines and harpagos modified, as shown in the illustrations.

20. ANOPHELES SUBPICTUS var. INDEFINITUS Ludlow, 1904. Plate 20.

Resembles *ludlowi* except that the legs are not speckled.

Palpi as in *ludlowi,* but the extra dark band on segment 5 has not been observed.

Proboscis dark, except labella.

Wings with humeral spot always present; presector costal spot sometimes absent; dark presector spot on vein 1 usually over half the length of the costal dark spot above; costal subapical dark spot as long or longer than pale area on either side; scattered white scales may be present on prehumeral area of costa; fringe spot between 5.2 and 6 sometimes present.

Legs dark, not speckled; fore tarsi 3 and 4 basally and apically banded in male and female, though less distinct in male; 1 apically and 5 basally banded; midtarsi with 1 to 3 narrowly banded apically, usually with basal patch on 2 to 4; hind tarsi with 1 to 4 apically but not basally banded; 5 entirely dark.

Abdomen as in *ludlowi.*

Male terminalia: Dorsal lobe of harpago with a club; a spine external to club, about as long as club itself in one specimen; ventral lobe with apical spine over twice the length of club; sometimes with two apical hairs; one or two external spines, sometimes flattened; variable in length; one to five internal spines or none. Phallosome with six to thirteen leaflets on either side, most of them serrated.

21. ANOPHELES VAGUS var. LIMOSUS King, 1932. Plate 21.

Resembles *subpictus* var. *indefinitus.*

Palpi of female similar in markings to those of *subpictus,* except that usually the preapical dark ring is half or less the length of apical white ring. Palpi of male similar to those of *subpictus,* except that usually the pale area before the enlargement of segment 3 is much narrower.

Proboscis as in *subpictus* var. *indefinitus.*

Wings much as in *subpictus,* from which they differ only in having the preapical dark costal area usually much shorter than the pale area on either side; presector dark spot on vein 1 half or less the costal spot above; prehumeral dark area seldom with white scales.

Legs dark; fore tarsi as of *indefinitus,* but male sometimes without basal band on 4 and without apical band on 3; mid- and hind tarsi much like those of *subpictus.*

Male terminalia: Dorsal lobe of harpago with a club; ventral lobe with apical spine about twice the length of club; one or

two, short, external spines; no internal spines (Plate 21). Phallosome leaflets comparatively long, serrated; usually five on either side.

22. ANOPHELES ANNULARIS van der Wulp, 1884. Plate 22.

Anopheles fuliginosus Giles, 1900.

Medium-sized, darkish, with very conspicuous white on hind legs; anopheline in attitude.

Palpi of female with terminal segment completely white or sometimes with a patch of black scales at about middle; narrow bands at 2–3 and 3–4. Palpi of male with some white scales on dorsal aspect of 2, a few scattered ones on 3; 4 and 5 black at base and toward outer sides, remaining area (middle to apex and inner sides) white.

Wings of pure white and black areas; humeral spot sometimes very tiny; subcostal spot in female often involving anterior portion of vein 1; in male involving vein 1 entirely; black and white areas vary in extent in different specimens; vein 5 with a black area at point of bifurcation; fringe spots opposite veins 2.1 to 6, except 2.2; white areas in the male more extensive.

Legs with midfemora and sometimes also hind femora with conspicuous pale spot on anterior surface toward apex; fore tarsi 1, 2, and 3 with wide apical bands; midtarsi 1 and 2 widely banded apically; 3 sometimes completely banded at apex, sometimes with only a patch or else entirely dark; hind-tarsal segment 1 apically banded; 2 with apical one-eighth to more than one-third white; 3, 4, and 5 entirely white.

Abdomen dark; on VI to VIII or VII and VIII, with some scales dorsally toward apices and sides, in some cases forming lateral tufts; VIII sometimes with white scales ventrally toward the sides in female; male with numerous white scales on VIII and IX on the upper (really the ventral) side.

Male terminalia: Dorsal lobe of harpago with a club sometimes duplicated, or incompletely fused; ventral lobe with apical spine longer than club; external spine one, about as long as club; usually two internal spines, about as long as club. Phallosome with broad fairly well serrated leaflets, the largest ones with tiny projections even on their broad surfaces; five or six leaflets on either side.

23. ANOPHELES KARWARI James, 1903. Plate 23.

Medium-sized, with conspicuous hind-tarsal bandings.

Palpi of female with segment 2 black, with narrow pale apical ring; 3 dark, with conspicuous white apical band; 4

white, with black basal band; 5 with apical two-thirds, or so, white; base black. Palpi of male as shown in Plate 23.

Proboscis dark, except labella.

Wings as figured in Plate 23. The dark areas somewhat variable; frequently there are two instead of three dark spots on vein 1 under the main costal dark area; 2.1 often has only the apical dark area, while 2.2 occasionally has only the basal dark area.

Legs with fore-tarsal segments 1 to 3 conspicuously, and 4 narrowly, banded apically. Midtarsi with narrow apical bands on 1 to 3; hind tarsi with 1 narrowly, 2 and 3 widely, banded at apices; 4 with wide apical and basal bands; 5 entirely white.

Abdomen dark, with golden scales on dorsum of VIII.

Male terminalia: Dorsal lobe of harpago with a club; apical spine of ventral lobe about half again as long as club; external spine very short and stout; internal spine shorter than club. Phallosome leaflets much like those of *maculatus* but not as broad; serrated; six leaflets on one side and seven on the other in specimens dissected. We have only a few males of this species.

24. ANOPHELES MACULATUS Theobald, 1901. Plate 24.

Medium-sized to moderately large. Hind legs conspicuous for their wide white bands. Those from the Baguio highlands generally larger and darker than those from the lowlands.

None of the females in our collection shows speckling on the palpi; but some of those from Baguio have a line of pale scales running lengthwise to a considerable distance in middle of segment 3. A pale ring located at 2–3; apex of 3 and base of 4 both white, forming the subapical white band; middle of 4 black, which constitutes the subapical black band; its apex, together with the entirely white segment 5, forms the apical white band; sometimes there are a few dark scales near the tip of segment 5. Palpi of male with variable pale area at middle of segment 2; pale ring at 2–3; 3 mostly dark with a line of pale scales at middle, a subapical white band and an indefinite apical black ring contiguous with basal black area of 4; a black band at 4–5 continuous with the black area along outer sides of both 4 and 5, the remaining area of both segments white.

Proboscis dark, except labella.

Wings variable in markings. In specimens from Baguio (even the males) the dark areas are larger and more prominent than in those from the lowlands. The accessory sector spot does not

encroach even partly upon the costa, while the costal sector spot may be incomplete or small. The subapical dark spot is always very much longer than the apical dark spot, thus making the pale areas on either side quite inconspicuous. Not less than three dark areas on vein 6 have been found in the Baguio specimens. In the lowland forms, particularly those from northern Mindanao, the dark areas are much reduced so that the yellow parts are more conspicuous. The subapical dark area is only about as long as, or shorter than, the apical dark area, while the accessory sector spot extends to the costa. Some of the dark areas in this form may be absent, as that at the apex of 3 or at the base of 2.1. In one case, however, the basal dark spots of 4.1 and 4.2 are contiguous with that on the apex of the petiole. Not infrequently there are two dark spots on vein 6.

Legs dark, with well-contrasted pale spots. Fore tarsi 1 with pale apical patch or band; apical and basal patches or bands on 2 and 3; 4 with basal patch and 5 all dark. Usually only 1 and 2 of the midleg have apical patches which are less distinct than those of the foreleg. Hind-tarsal segment 1 with narrow apical patch or ring, 2 with wide apical white band; 3 and 4 both broadly banded at bases and apices, 5 entirely white.

Abdomen: In our collections from both highlands and lowlands of Luzon and Mindanao only the typical form seems to be represented. Generally specimens from Luzon, including the highlands (Baguio), tend to have very scanty scalings, on the abdominal tergites. Those from Mindanao show more scales, usually a few narrow ones on II, increasing in number and becoming broader on the posterior segments. In some a few black scales are mixed with the other scales along the posterolateral sides of segments VI to VIII, forming, in a few cases, lateral scale tufts.

Male terminalia: Dorsal lobe of harpago, with a club, not completely fused at times; ventral lobe with apical spine longer than club; external spine seldom present; internal spine usually present, rarely absent, sometimes in duplicate. Phallosome with broad serrated leaflets numbering five to seven on either side; the largest ones have spinous projections even on the broad surface. Specimens from highlands and lowlands and from different islands are very much alike (Plate 24) in the characters of the male terminalia.

25. ANOPHELES PHILIPPINENSIS Ludlow, 1902. Plate 25.

Medium-sized, with conspicuous white on hind legs.

Palpi of female dark; narrow pale bands at 2–3 and 3–4; apical segment entirely white and apex of 4 white, together forming the apical band. Palpi of male dark; a pale ring at 2–3; a pale subapical internal patch on 3, the apex dark; bases and outer sides of 4 and 5 dark, the rest white.

Proboscis dark, except labella.

Wings, as figured, can be differentiated from those of *annularis* (*fuliginosus*) by the yellow and dark scalings, and particularly by the absence of dark scales at the middle of the continuous pale area formed by 5.2 and its petiole; *annularis* (*fuliginosus*) has black and white scales and an extensive dark area at the middle of the vein mentioned.

Abdomen with dorsum dark and with dark and pale scales usually at the lateral sides of the posterior ends of segments V to VIII, forming lateral tufts. Ventrally there may be a few scales along the sides of these segments, but the scales are prominent toward the midposterior end of VII and a number in middle of VIII. In the male the lateral scale tufts are insignificant or wanting. Cerci of female and terminal segment of male covered with scales.

Legs dark with pale patches on apices of femora and tibiæ; a pale longitudinal line running almost the entire lengths of midfemora and hind femora and tibiæ underneath. Fore tarsi 1 to 3 widely banded apically; midtarsi with narrow ring or patch at apices of 1 to 3; a tiny pale patch on apex of first hind tarsus; a variable wide area at apex of 2; 3 to 5 entirely white.

Male terminalia: Harpago very variable; no two individuals of those dissected are alike; and no two harpagos in an individual, except in one, are exactly the same. Dorsal lobe has a club and may have a subsidiary club; ventral lobe with apical spine longer than club; one or two external spines, about as long as club or longer, but may be very short; sometimes much flattened and once seen to be clubbed; one to four internal spines slender, about as long as club, or longer. Phallosome with five to nine serrated leaflets on either side in addition to the fine spines that are sometimes present.

26. Balabac ANOPHELES species or variety (?). Plate 26.

See discussion under *leucosphyrus*. Male and female much like *leucosphyrus;* anopheline in attitude when at rest.

Palpi like those of *leucosphyrus* in both sexes.

Proboscis as in *leucosphyrus.*

Wings similar to those of *leucosphyrus,* except that the prehumeral pale spot is usually tiny or absent and a costal accessory sector pale spot is sometimes present.

Legs as in *leucosphyrus,* but the fore-tarsal bandings are complete and distinct; and the fourth hind-tarsal segment has a pale band or patch at base.

Abdomen similar to that of *leucosphyrus.*

Male terminalia: Dorsal lobe of harpago with a club; apical spine of ventral lobe a little shorter than club; no external spine; one internal spine, over half the length of club. Phallosome usually with eight serrated leaflets on either side.

27. ANOPHELES near-LEUCOSPHYRUS (?). Plate 27.

See discussion under *leucosphyrus.* Rather small delicate mosquitoes; anopheline in attitude.

Palpi as in *leucosphyrus* in both sexes.

Proboscis as in *leucosphyrus.*

Wings much as in *leucosphyrus;* prehumeral pale spot usually absent; accessory sector pale spot on costa sometimes present.

Legs as in *leucosphyrus.*

Abdomen as in *leucosphyrus.*

Male terminalia: Harpago similar to that of *leucosphyrus;* in one a duplication of both apical and external spines was found. Phallosome with about seven short serrated leaflets on either side.

28. ANOPHELES of AITKENI group (?).

From Mount Banahao, Luzon. Included in our key to the larvæ of Philippine anopheles. No adult known.

KEY TO THE PHILIPPINE SPECIES OF ANOPHELES

The Anophelini are a tribe of the subfamily Culicinæ, family Culicidæ, order Diptera. As a rule the Anophelini are separated from other Culicidæ by several criteria, some of which are the following:

The wings of the commoner anophelines are usually distinctly spotted. However, this criterion is not always clear, for some anophelines have wings that are not spotted. In others the spots are so small as to be almost invisible without a lens. Also spotting is seen in a few species of mosquitoes that are not in the tribe Anophelini.

The palpi of both sexes of Anophelini are long, being about equal to the proboscis. The male palpi have a clubbed end, the last two apical segments being enlarged and somewhat flattened.

The resting attitude of an anopheline is apt to be characteristically different from that of other mosquitoes. As a rule the body of the anopheline is held at an angle with the surface on which the insect is resting. This angle may be as great as 90° but usually is from 30° to 45°. In *Culex* mosquitoes the body is usually held horizontally, parallel to the resting surface, the thorax sometimes giving the insect a "hump-backed" appearance. This criterion is not always dependable as some anophelines assume usually, or at times, a *Culex*-like attitude; but in many anophelines the body is held quite straight, at an angle with the resting surface.

The abdomen of Anophelini is either entirely devoid of scales or else has a variable development of loosely applied scales. Even in the most scaly species the sternites, at least, are largely bare. The tribes Megarhinini and Culicini have both tergites and sternites clothed with scales. The scutellum of Anophelini is evenly rounded.

The males of Anophelini have a large single claw on each foreleg.

The following key applies to Philippine Anophelini.

Key to adult Philippine Anopheles mosquitoes.

1. Hind legs with one or more segments widely banded[2] or completely white .... 2.
   Hind legs with one or more segments narrowly banded or all segments entirely dark .... 11.
2. At least the last tarsal segment of the hind leg completely white.......... 3.
   The last tarsal segment of the hind leg entirely black or incompletely white .... 6.
3. Third and fourth tarsal segments of hind leg also completely white.. 4.
   Third and fourth tarsal segments of hind leg not completely white.... 5.
4. A dark area at the bifurcation point of longitudinal wing vein 5. *fuliginosus.*
   No dark area at the bifurcation point of longitudinal wing vein 5. *philippinensis.*
5. Legs spotted; wing vein 6 usually with three dark spots.... *maculatus.*
   Legs not spotted; wing vein 6 with two dark spots.......... *karwari.*
6. Legs spotted .... 7.
   Legs not spotted .... 10.

[2] A wide band is one that will easily cover at least one-fourth of the third hind-tarsal segment. It can easily be seen with the unaided eye. A narrow band will cover at most about a tenth, usually less, of the third hind-tarsal segment. It can be seen with the naked eye, if at all, as a mere shiny speck.

7. Tibiotarsal articulation of hind leg not covered with wide band; abdomen with ventral scale tufts on segments II to VII; mesonotum with two distinct eyelike spots........ *kochi.*
   Tibiotarsal articulation of hind leg covered with continuous broad white "knee" band; abdominal segments without ventral scale tufts except sometimes on VI and VII; mesonotum without eyelike spots..8.
8. Fourth hind tarsal segment with a band or patch of pale scales at base; fore-tarsal bands distinct and complete. Balabac species or variety (?).
   Fourth hind tarsal segment entirely dark at base; fore-tarsal bands often incomplete or indistinct........ 9.
9. Posterior petiole index about 1.5, usually more;[3] anterior forked cell base not in line with that of posterior forked cell but nearer the wing base; prehumeral wing spot small or absent. near-*leucosphyrus.*
   Posterior petiole index about 1.0, usually less; anterior forked cell base in line with that of posterior forked cell or else farther from wing base; prehumeral wing spot large........ *leucosphyrus.*
10. Femur of hind leg widely banded near the middle; wing veins 5 and 6 extensively dark; subcostal wing spot absent. *lindesayi* var. *benguetensis.*
   Femur of hind leg not banded near the middle; wing veins 5 and 6 extensively pale; subcostal wing spot present. *hyrcanus* var. *nigerrimus.*
11. Legs conspicuously spotted .... 12.
   Legs not spotted or with scattered white scales only........ 16.
12. One or more dark patches at or near bifurcation point of wing vein 5; posterior branch of vein 2 (2.2) usually with three or more dark patches .... 13.
   No dark patch at or near bifurcation point of wing vein 5; posterior branch of vein 2 (2.2) with not more than two dark patches........ 14.
13. Dark patches at middle of wing vein 3; abdominal tergites devoid of scales .... *tessellatus.*
   No dark patches at middle of wing vein 3; abdominal tergites with numerous scales .... *kolambuganensis.*
14. Three dark patches on wing vein 6; pale fringe spot between apices of forks of vein 5 (5.1 and 5.2)........ *parangensis.*
   Two dark patches on wing vein 6; no pale fringe spot between apices of forks of vein 5 (5.1 and 5.2)........ 15.
15. Broad flat scales on fossa of mesonotum, in male two to four, in female six to more than ten; femora and tibiæ of midlegs and hind legs, and fore tarsi largely pale-scaled beneath........ *litoralis.*
   Broad flat scales on fossa of mesonotum wanting in male, sometimes one or two present in female; femora and tibiæ of midlegs and hind legs and fore tarsi largely dark-scaled beneath........ *ludlowi.*
16. Wings entirely dark .... 17.
   Wings with a pale area .... 18.

[3] The posterior petiole index is obtained by dividing the length of the petiole of the posterior forked cell of the wing by the length of vein 4.2.

17. Phallosome without leaflets or spinous projections.
aitkeni var. *bengalensis*.
Phallosome without leaflets, but with spinous projections.
insulæflorum.
18. Costal wing margin without sector and presector spots........................ 19.
Costal wing margin with either sector or presector spot, or both.... 22.
19. Basal third of costa, including that part under it of the subcosta and vein 1, with pale interruptions or scattered pale scales; two or more of fore and hind tarsal segments with distinct apical band or patch .... 20.
Basal third of costa including that part under it of the subcosta and vein 1 without pale interruptions or scattered pale scales; fore and hind tarsal segments entirely dark or with indistinct pale patches.
baezai (?).
20. Femora and tibiæ with distinct scattered white scales; ventral white scale tufts very conspicuous...................................... *pseudobarbirostris*.
Femora and tibiæ without scattered white scales; ventral white scale tufts absent or very inconspicuous.. 21.
21. Apex of wing with a wide pale fringe spot extending to at least the apices of vein 3 and posterior branch of vein 2 (2.2); subapical pale costal spot does not involve extreme tips of vein 1 and 2.1; palpi of male with extensive white scaling on club; palpi of female banded.
hyrcanus var. *sinensis*.
Apex of wing with narrow pale fringe spots; subapical pale costal spot involves extreme tips of veins 1 and 2.1; palpi of male extensively dark on club; palpi of female not banded.......................... *barbirostris*.
22. Wing fringe spots opposite the apices of from vein 2.2 to vein 6 absent; usually one spot between 5.2 and 6; a very large mosquito, largest Philippine *Anopheles*................................ *gigas* var. *formosus*.
Fringe spots present on all or most of the apices of veins 1 to 6; small or medium-sized mosquitoes.. 23.
23. No dark area at bifurcation point of vein 5; two or more segments of fore tarsi apically and basally banded; brownish mosquitoes........ 24.
A dark area at bifurcation point of vein 5; fore tarsi entirely dark or with only a few pale scales or a minute ring apically; blackish mosquitoes .... 25.
24. Subapical black area of wing as long as the pale area on either side or longer; presector dark area on vein 1 over half the length of the costal spot above.. *subpictus* var. *indefinitus*.
Subapical black area of wing much shorter than the pale area on either side; presector dark area on vein 1 less than half the length of the costal spot above or entirely absent........ *vagus* var. *limosus*.
25. One or two of fore-tarsal segments with a ring or pale patch apically.
filipinæ.
Fore-tarsal segments entirely dark.. 26.
26. Costal humeral spot of wing present and complete; apical half of female entirely dark .... *mangyanus*.
Costal humeral spot of wing absent or incomplete; proboscis of female proboscis with pale scalings ventrally and laterally.
minimus var. *flavirostris*.

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ILLUSTRATIONS

1, Palp.
2, Proboscis.
3, Mesonotum.
4, Wing.
5, Leg.
  a, Foreleg.
  b, Middle leg.
  c, Hind leg.
6, Abdomen.
  a, Dorsal.
  b, Ventral.

7, Terminalia.
  A, Harpago.
    x, Dorsal lobe.
      a, External part.
      b, Internal part.
    y, Ventral lobe.
      a, External spine.
      b, Internal spine.
  B, Phallosome.
    a, Stem.
    b, Leaflets.
  C, Process of segment IX.
  D, Coxite.
    a, Expanded organ on side of coxite.
  E, Style.

[Only the parts necessary for the identification of the species are shown in any plate. Unless otherwise noted below, when there are two or more drawings of the same part—for example, the harpago—they represent common variations. If these variations have geographic or unusual significance the fact is mentioned. Frequently both the male and the female palps are shown; the former has a more prominent club at the outer tip than the latter. When the palps of both sexes are shown, those of the male are the upper. Frequently only a part of a leg is drawn; sometimes only the tarsal segments are required for identification.]

PLATE 1. ANOPHELES AITKENI VAR. BENGALENSIS PURI

FIGS. 1 and 2. Palps and proboscis, upper, female; lower, male.
FIG. 4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Center, hind femur and tibia; at right, tarsal segments of hind leg.
7A. Harpago, *a*, external part, *b*, internal part of dorsal lobe.
7B. Phallosome.

PLATE 2. ANOPHELES GIGAS VAR. FORMOSUS LUDLOW

FIGS. 1 and 2. Palps and proboscis, upper, male; lower, female.
FIG. 4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Center, hind femur and tibia; at right, tarsal segments of hind leg.
7A. Various types of harpagos.
7B. Above, leaflets on one side; below, tip and leaflets of phallosome, showing variations in serrations of leaflets.

PLATE 3. ANOPHELES INSULÆFLORUM SWELLENGREBEL AND SWELLENGREBEL DE GRAAF

FIG. 1. Palps, above, male; below, female.
2. Female proboscis.
4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Two types of harpagos.
7B. Two types of phallosomes.

PLATE 4. ANOPHELES LINDESAYI VAR. BENGUETENSIS KING

FIG. 1. Upper, male palp; below, female palp.
2. Female proboscis.
4. Wing.
5a. Fore-tarsal segments.
5c. In middle, hind femur; at right, tarsal segments of hind leg.
7A. Types of harpagos.
7B. Tip and leaflets on one side of phallosome.

PLATE 5. ANOPHELES BAEZAI GATER (VAR. ?)

FIGS. 1 and 2. Palps and proboscis, upper, male; lower, female.
FIG. 4. Wing.
5a. Fore-tarsal segments.
5c. (Right) first, and (middle) second, third, fourth, and fifth hind tarsal segments.
7A. Harpago from one individual showing how one side differs from the other.
7B. Above, tip and leaflets of phallosome without serrations; below, tip and leaflets of phallosome with serrations.
7C. Process of abdominal segment IX.

PLATE 6. ANOPHELES BARBIROSTRIS VAN DER WULP

FIGS. 1 and 2. Palps and proboscis, upper, male; lower, female.
FIG. 4. Upper, whole wing of common form; lower, tip of wing showing variation of fringe spots, rarer form.
5a. Fore-tarsal segments, Philippine specimen.
5c. Middle, hind-tarsal segments, Indian specimen, showing more-marked white rings. Right, hind-tarsal segments, Philippine specimen.
6a. Upper, ventral side of abdomen, Philippine form, having very few white scales. Lower, ventral side of abdomen, Indian form, having many white scales.
7A. Harpago, one side.
7B. *b*, Leaflets on one side of phallosome.
7C. Process of abdominal segment IX.

PLATE 7. ANOPHELES HYRCANUS VAR. NIGERRIMUS GILES

FIGS. 1 and 2. Palps and proboscis, upper, male; lower female.
FIG. 4. Wing, upper, common form; lower, less common, tip of wing showing much wider pale spot at apex.
5a. Fore-tarsal segments.
5c. Hind-tarsal segments.
7A. Harpago, one side.
7B. Phallosomes, apical portion, showing variations in the size, shape, and serrations of leaflets; upper left and lower right, Luzon forms; upper right, Mindanao form.
7C. Process of abdominal segment IX.

PLATE 8. ANOPHELES HYRCANUS VAR. SINENSIS WIEDEMANN

FIG. 1. Palps, left, male; right, female.
2. Female proboscis.
4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Tips of phallosomes showing variations in leaflets; upper right, Luzon lowland form; upper left, Hongkong form; lower right and left, Baguio (highland) form.
7B. Parts of harpagos, showing variations in the spines and club-shaped process; upper right, Philippine form with club not fused; lower midlde, spines of harpago, Hongkong form; lower left, Baguio form.
7C. Process of abdominal segment IX.

PLATE 9. ANOPHELES PSEUDOBARBIROSTRIS LUDLOW

FIGS. 1 and 2. Palps and proboscis, upper, female; lower, male.
FIG. 4. Wing.
5*a*. Upper, fore-tarsal segments; lower, part of fore femur showing white scales, enlarged.
5*c*. Hind-tarsal segments.
6*b*. Ventral aspect of abdomen showing tuft of white scales.
7A. Two types of harpagos.
7B. Tips and leaflets of phallosome, at left, usual form; at right, abnormal duplication of the shorter leaflets.
7C. Process of abdominal segment IX.

PLATE 10. ANOPHELES KOCHI DÖNITZ

FIG. 1. Palps, upper, male; lower, female.
2. Female proboscis.
4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
6*b*. Ventral aspect of abdomen showing black scale tuft.
7A. Two types of harpagos.
7B. Tips and leaflets on one side of phallosome, showing variations in leaflets.

PLATE 11. ANOPHELES KOLAMBUGANENSIS BAISAS

FIG. 1. Palps, upper, male; lower, female.
2. Female proboscis.
4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
6*a*. Dorsal aspect of abdomen showing scales, hairs omitted.
7A. Harpago, one side.
7B. Tips of phallosome showing leaflets.

PLATE 12. ANOPHELES LEUCOSPHYRUS DÖNITZ

FIGS. 1 and 2. Palps and proboscis, upper, male; lower, female.
FIG. 4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Upper right, hind femur; middle, hind tibia and first tarsal segment; lower right, second, third, fourth, and fifth tarsal segments of hind leg.
7A. Harpagos showing variations in the clublike process.
7B. Tip of leaflets of phallosome.

PLATE 13. ANOPHELES TESSELLATUS THEOBALD

FIGS. 1 and 2. Palps and proboscis, upper, female; lower, male.
FIG. 4. Upper, costa showing variation in costal markings; lower, whole wing, usual form.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Two types of harpagos.
7B. Tips and leaflets of phallosome showing variations in the size and serrations of leaflets; upper and middle, Luzon forms; lower, Mindanao form.

PLATE 14. ANOPHELES FILIPINÆ MANALANG

FIG. 1. Palps, upper, male; lower, female.
2. Female proboscis.
4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments, the upper being the first.
7A. Types of harpagos.
7B. Tip and leaflets of phallosome.

PLATE 15. ANOPHELES MANGYANUS BANKS

FIGS. 1 and 2. Palps and proboscis, upper, female; lower, male palps.
FIG. 4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Two types of harpagos.
7B. Tips and leaflets of phallosome.

PLATE 16. ANOPHELES MINIMUS VAR. FLAVIROSTRIS LUDLOW

FIGS. 1 and 2. Palps and proboscis, upper, male; lower, female.
FIG. 4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Two types of harpagos.
7B. Tips and leaflets of phallosomes.

PLATE 17. ANOPHELES LITORALIS KING

FIG. 1. Palps, upper, male; lower, female.
2. Female proboscis.
4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Different types of harpagos.
7B. Tips and leaflets of phallosome.

PLATE 18. ANOPHELES LUDLOWI THEOBALD

FIG. 1. Upper, male palp; middle (usual), lower (with extra dark ring, unusual) female palps.
FIG. 2. Female proboscis, lower.
FIG. 4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Harpargo, one side.
7B. Tip and leaflets of phallosome; the right side representing an unusual form.

PLATE 19. ANOPHELES PARANGENSIS LUDLOW

FIG. 1. Palps, upper, female; lower, male.
2. Proboscis, upper, female; lower, male.
4. Upper, costa of wing showing tiny subapical dark costal spot; continuous midcostal dark area; very tiny outer accessory spot; and two dark spots under the midcostal dark area. Lower, whole wing. Note the broken midcostal dark area, and the pale fringe spot between the apices of forks of vein 5, which is fused with the pale fringe spot opposite vein 5.2.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Harpago of male terminalia.
7B. Phallosome of male terminalia.
7D. *a*, Expanded organ on side of coxite.

PLATE 20. ANOPHELES SUBPICTUS VAR. INDEFINITUS LUDLOW

FIG. 1. Palp, upper, male; lower, female.
2. Female proboscis.
4. Wing, upper, costa showing variation in markings.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Two types of harpagos.
7B. Tips and leaflets of phallosome.

PLATE 21. ANOPHELES VAGUS VAR. LIMOSUS KING

FIGS. 1 and 2. Palps and proboscis, upper, female; lower, male.
FIG. 4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Harpagos.
7B. Tips and leaflets of phallosomes.

PLATE 22. ANOPHELES ANNULARIS VAN DER WULP

FIGS. 1 and 2. Palps and proboscis, upper, female; lower, male.
FIG. 4. Wing.
5*a*. Fore-tarsal segments.
5*b*. Femur of midleg.
5*c*. Hind-tarsal segments.
7A. Two types of harpagos.
7B. Tips and leaflets of phallosomes.

PLATE 23. ANOPHELES KARWARI JAMES

FIG. 1. Palps, upper, male; lower, female.
2. Female proboscis.
4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Harpago, from one individual.
7B. Tip and leaflets of phallosome.

PLATE 24. ANOPHELES MACULATUS THEOBALD

FIG. 1. Palps, upper, male; lower, female.
2. Female proboscis.
4. Wings; uppermost, costa of an unusually large specimen from Baguio; second, costa showing variation in markings; middle and lower, whole wings showing variations in markings.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
6*a*. Dorsal aspect of abdominal segment II showing (left) few, narrow scales in the Philippine form, and (right) numerous, broad scales in the Indian form, hairs omitted.
7A. Harpago, one side.
7B. Tips and leaflets of phallosomes.

PLATE 25. ANOPHELES PHILIPPINENSIS LUDLOW

FIG. 1. Palps, upper, male; lower, female.
FIG. 2. Female proboscis.
FIG. 4. Wing.
5*a*. Fore-tarsal segments.
5*b*. Midfemur.
5*c*. Hind-tarsal segments.
7A. Showing great variations in harpagos.
7B. Tips and leaflets of phallosomes.

PLATE 26. BALABAC ANOPHELES SPECIES OR VARIETY

FIG. 1. Palps, right, male; left, female.
2. Female proboscis.
4. Wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments, including tibiotarsal white-banded joint.
7A. Different types of harpagos.
7B. Tips and leaflets of phallosomes.

PLATE 27. ANOPHELES NEAR-LEUCOSPHYRUS KING

FIG. 1. Palps, upper, male; lower, female.
2. Female proboscis.
4. Upper, costa showing variation in markings; lower, whole wing.
5*a*. Fore-tarsal segments.
5*c*. Hind-tarsal segments.
7A. Different types of harpagos.
7B. Tips and leaflets of phallosomes.

PLATE 28. ANOPHELES MINIMUS VAR. FLAVIROSTRIS LUDLOW

PLATE 29. TYPICAL WINGS

FIG. 1. *Anopheles aitkeni* var. *bengalensis* Puri.
2. *Anopheles gigas* var. *formosus* Ludlow.
3. *Anopheles insulæflorum* Swellengrebel and Swellengrebel de Graaf.
4. *Anopheles lindesayi* var. *benguetensis* King.
5. *Anopheles baezai* Gater (variety ?).

PLATE 30. TYPICAL WINGS

FIG. 6. *Anopheles barbirostris* van der Wulp.
7. *Anopheles hyrcanus* var. *nigerrimus* Giles.
8. *Anopheles hyrcanus* var. *sinensis* Wiedemann.
9. *Anopheles pseudobarbirostris* Ludlow.
10. *Anopheles kochi* Dönitz.

PLATE 31. TYPICAL WINGS

FIG. 11. *Anopheles kolambuganensis* Baisas.
12. *Anopheles leucosphyrus* Dönitz.
13. *Anopheles tessellatus* Theobald.
14. *Anopheles filipinæ* Manalang.
15. *Anopheles mangyanus* Banks.

PLATE 32. TYPICAL WINGS

FIG. 16. *Anopheles minimus* var. *flavirostris* Ludlow.
17. *Anopheles litoralis* King.
18. *Anopheles ludlowi* Theobald.
20. *Anopheles subpictus* var. *indefinitus* Ludlow.
21. *Anopheles vagus* var. *limosus* King.

PLATE 33. TYPICAL WINGS

FIG. 22. *Anopheles annularis* van der Wulp.
23. *Anopheles karwari* James.
24. *Anopheles maculatus* Theobald.
25. *Anopheles philippinensis* Ludlow.
26. Balabac *Anopheles* species or variety.
27. *Anopheles* near-*leucosphyrus* King.

PLATE 34. TYPICAL ABDOMINAL SEGMENTS OF SOME PHILIPPINE ANOPHELES

FIG. 6. *Anopheles barbirostris* van der Wulp; ventral.
7. *Anopheles hyrcanus* var. *nigerrimus* Giles; ventral.

FIG. 9. *Anopheles pseudobarbirostris* Ludlow; ventral.
10. *Anopheles kochi* Dönitz; ventral.
11. *Anopheles kolambuganensis* Baisas; dorsal.

TEXT FIGURES

FIG. 1. *Anopheles maculatus* Theobald; head parts; *1*, palp; *2*, proboscis; *lb*, labella; *a*, antenna; *c*, clypeus; *lr*, tip of labium, epipharynx; *mb*, mandible; *mx*, maxilla; *v*, vertex; *vt*, vertical tuft; *e*, eye. (Camera-lucida drawing, semidiagrammatic.)

2. *Anopheles maculatus* Theobald; thorax; *pt*, prothorax; *ms*, mesothorax; *mt*, metathorax; *3*, mesonotum; *apl*, anterior pronotal lobe; *pph*, propleural hairs; *sc*, scutellum; *h*, halteres; *f*, fossa. (Camera-lucida drawing, semidiagrammatic.)

3. *Anopheles maculatus* Theobald; wing, upper figure shows venation; lower figure shows ornamentation. *a*, Apex; *b*, base; *c*, costa; *Sc*, subcosta; *f*, fringe; *1* to *6*, longitudinal veins; *2.1*, anterior branch of second longitudinal vein; *2.2*, posterior branch of second longitudinal vein; *cv*, crossveins; *hv*, humeral crossvein; *af*, anterior forked cell; *pf*, posterior forked cell; *ph*, prehumeral white spot; *hs*, humeral spot; *ps*, presector spot; *s*, sector spot; *as*, accessory sector spot; *pab*, preapical black spot; *scw*, subcostal white spot; *fs*, fringe spcts. (Camera-lucida drawing, semidiagrammatic.)

4. *Anopheles maculatus* Theobald; foreleg; *c*, coxa; *tr*, trochanter; *f*, femur; *tb*, tibia; *ts*, tarsal segments; *ab*, apical band; *bb*, basal band. (Camera-lucida drawing, semidiagrammatic.)

5. *Anopheles pseudobarbirostris* Ludlow; abdomen, segments I to VIII; *vt*, ventral tufts. (Camera-lucida drawing, semidiagrammatic.)

6. Male terminalia; *Anopheles maculatus* Theobald, upper; harpago of *A. maculatus* Theo., lower left; harpago of *A. aitkeni* var. *bengalensis* Puri, lower right. *A*, harpago; *x*, dorsal lobe; *y*, ventral lobe; *a*, external; *b*, internal; *as*, external spine; *bs*, internal spine; *cs*, apical spine; *B*, phallosome; *a*, stem; *b*, leaflets; D, coxite; E, style. (Camera-lucida drawing, semidiagrammatic.)

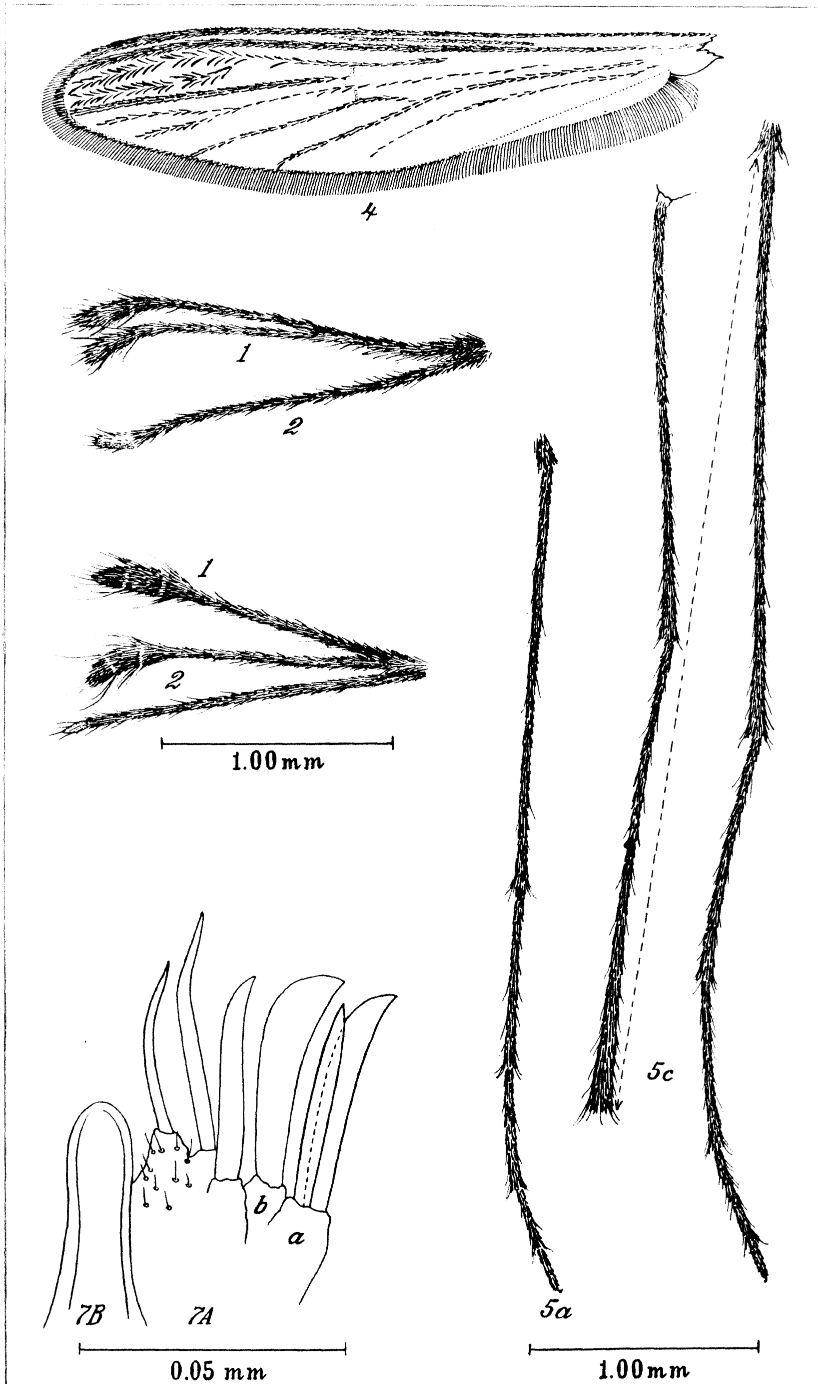

PLATE 1. ANOPHELES AITKENI VAR. BENGALENSIS.

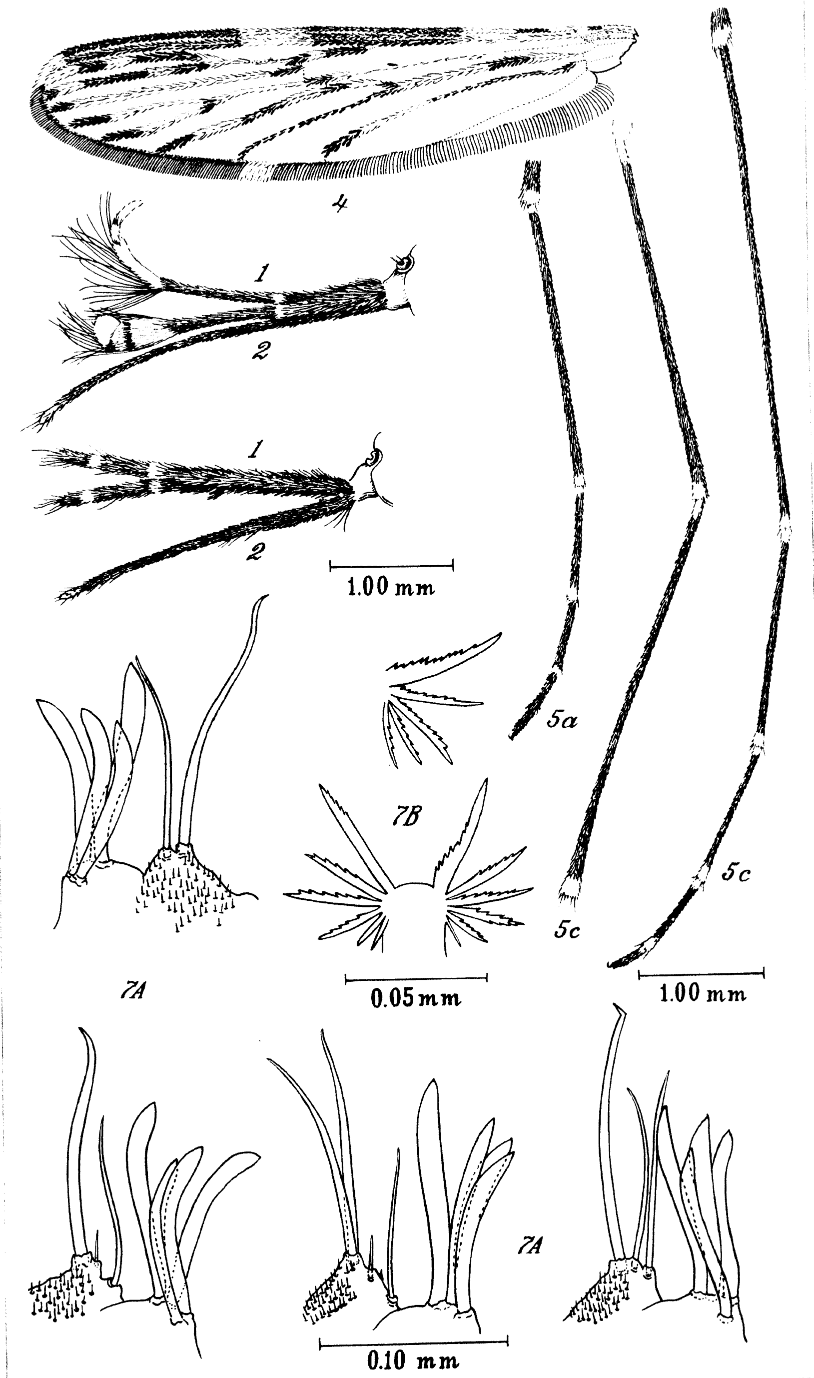

PLATE 2. ANOPHELES GIGAS VAR. FORMOSUS.

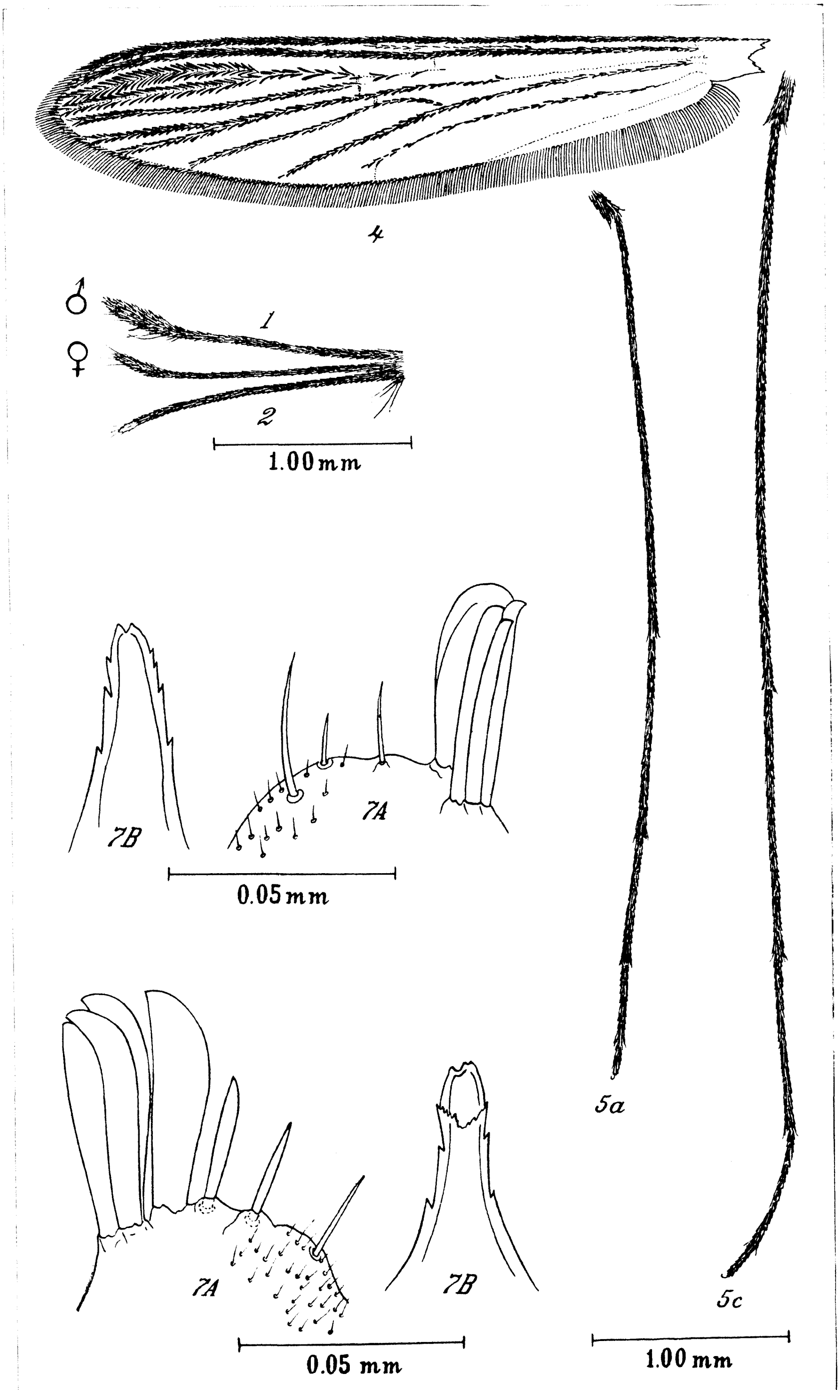

PLATE 3. ANOPHELES INSULÆFLORUM.

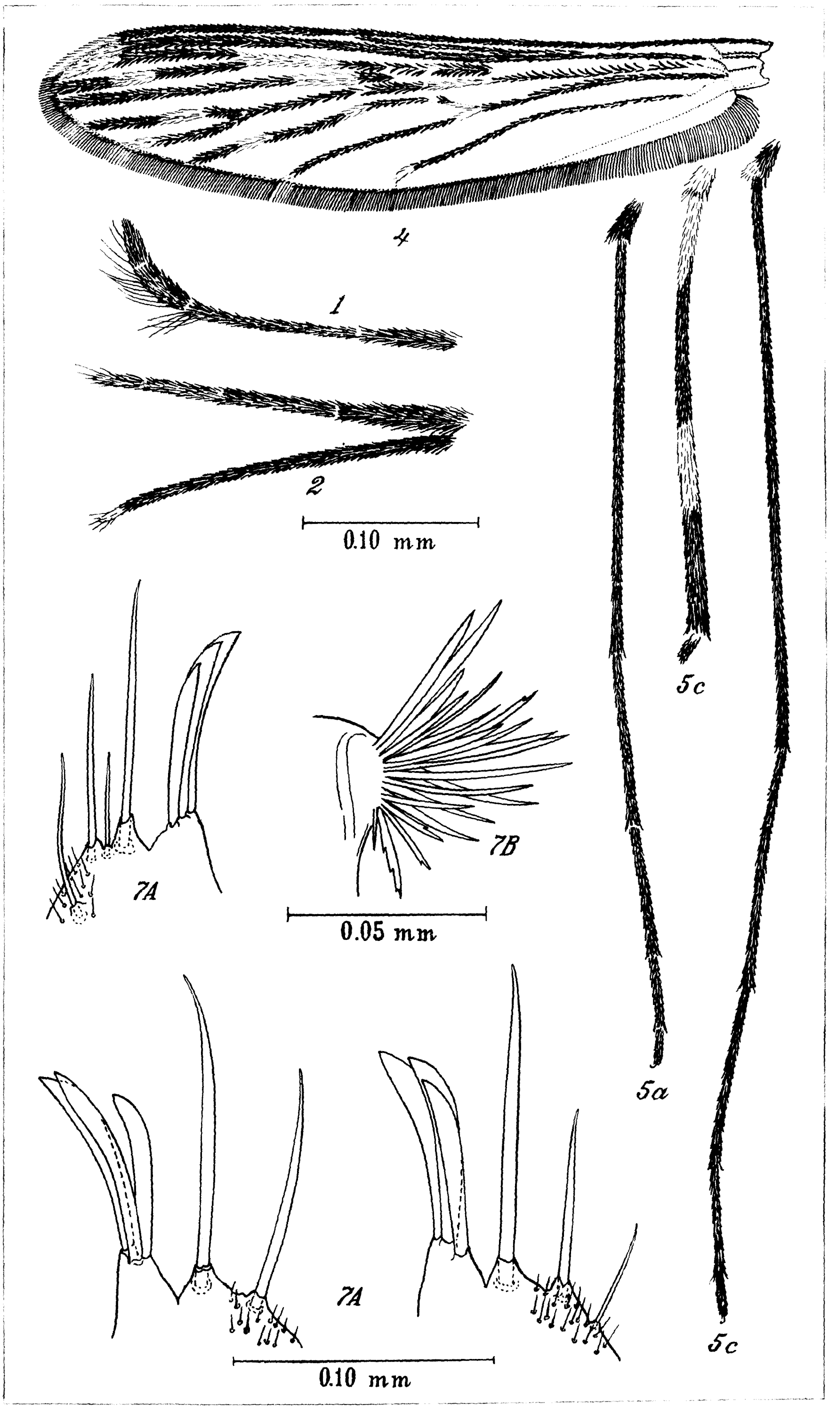

PLATE 4. ANOPHELES LINDESAYI VAR. BENGUETENSIS.

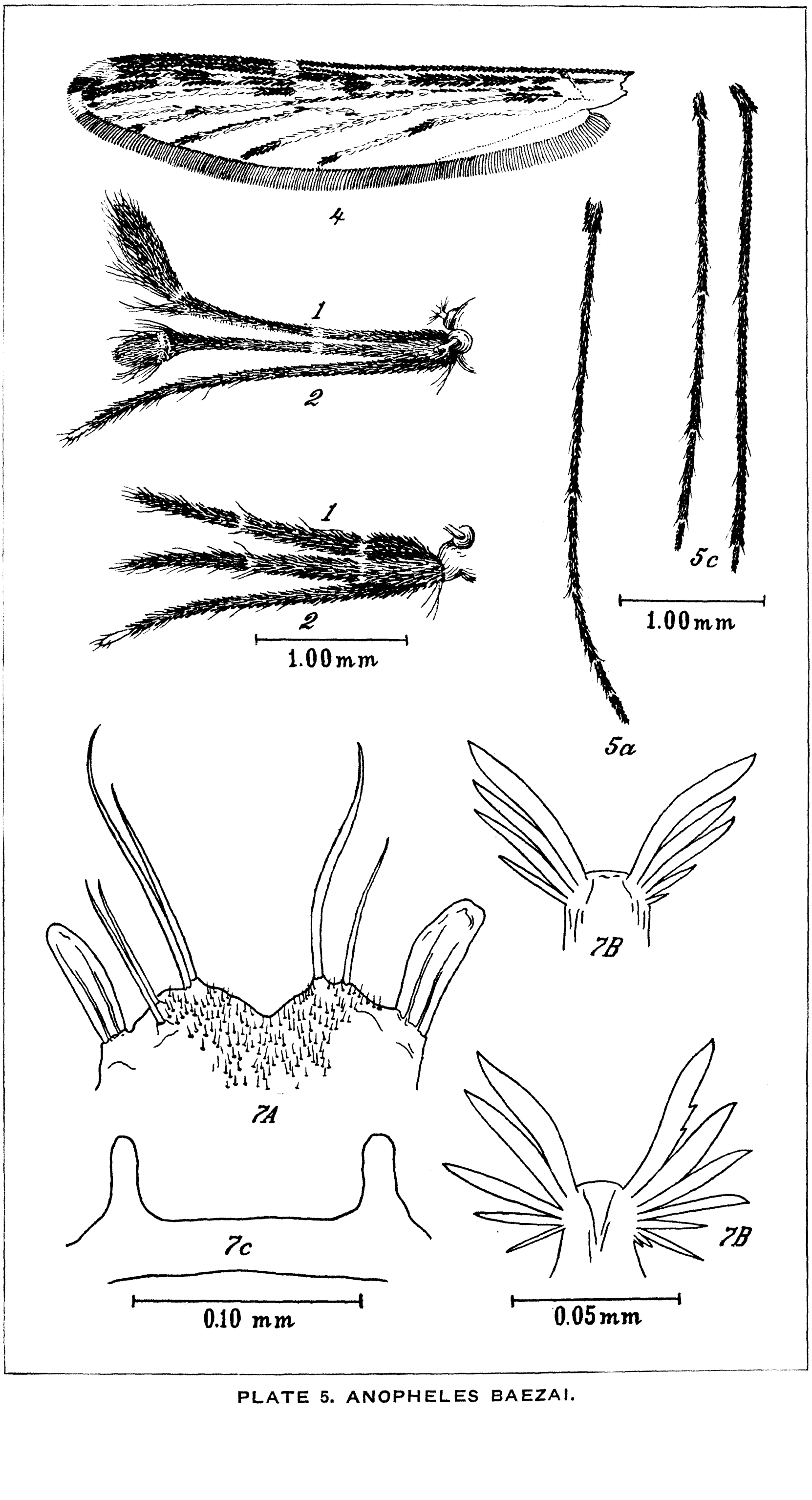

PLATE 5. ANOPHELES BAEZAI.

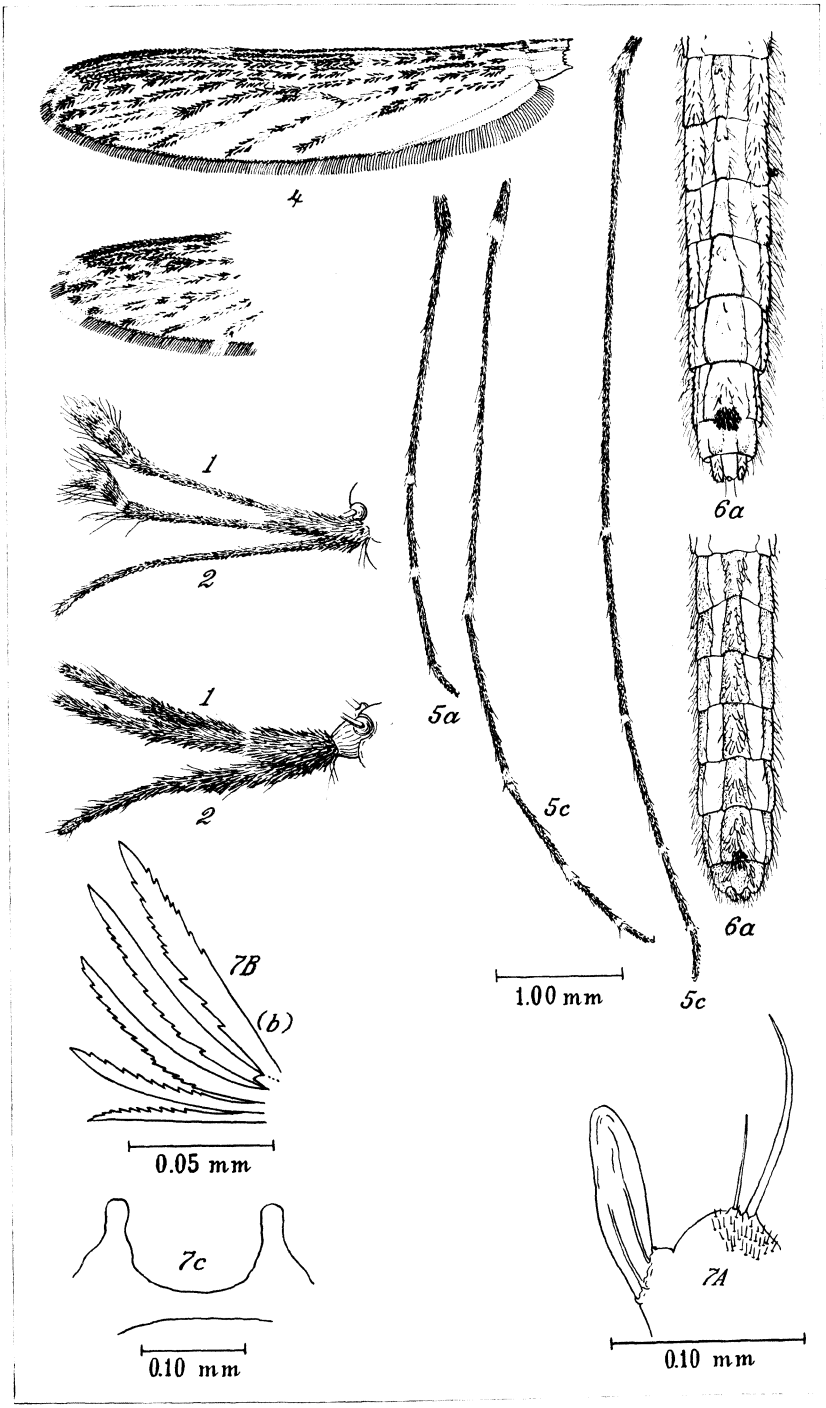

PLATE 6. ANOPHELES BARBIROSTRIS.

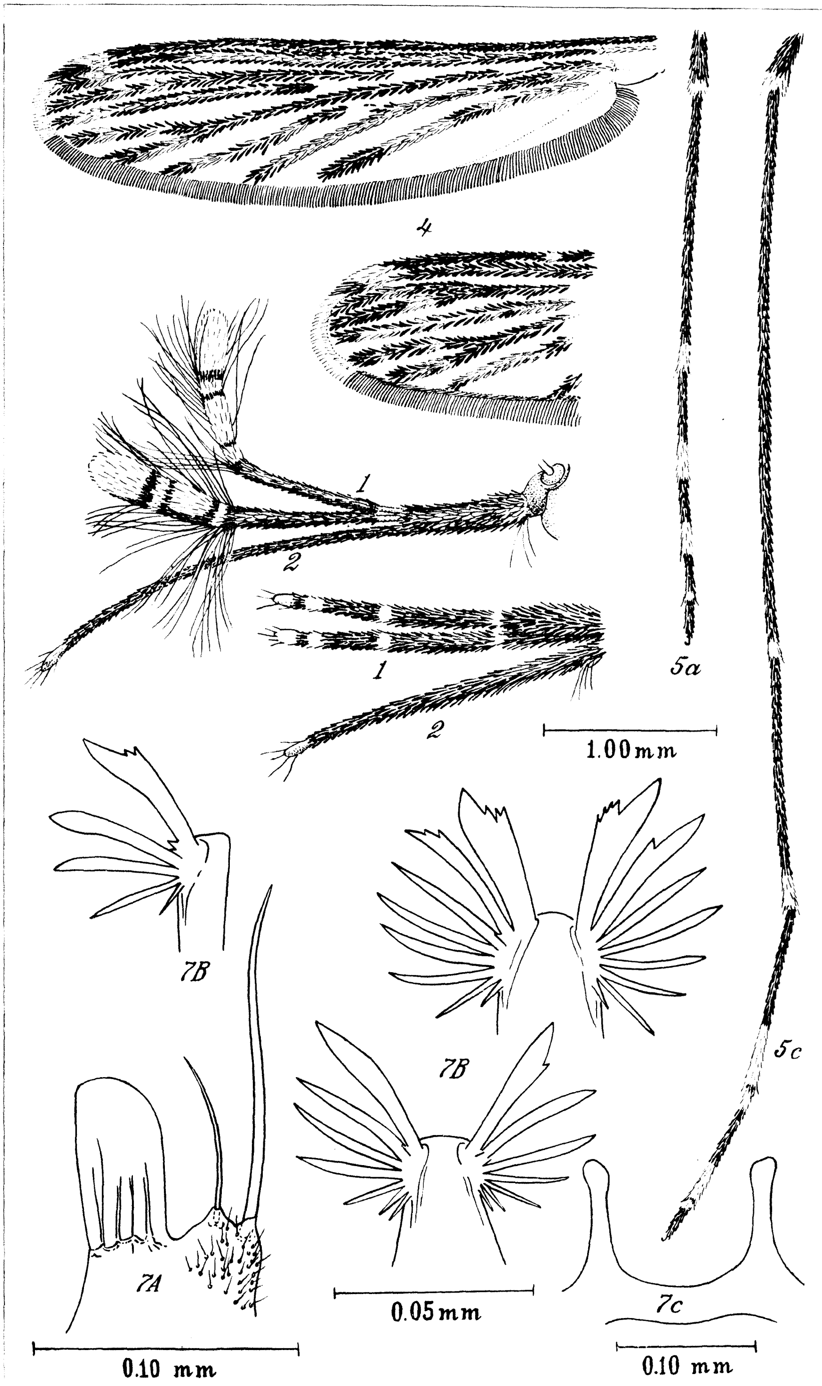

PLATE 7. ANOPHELES HYRCANUS VAR. NIGERRIMUS.

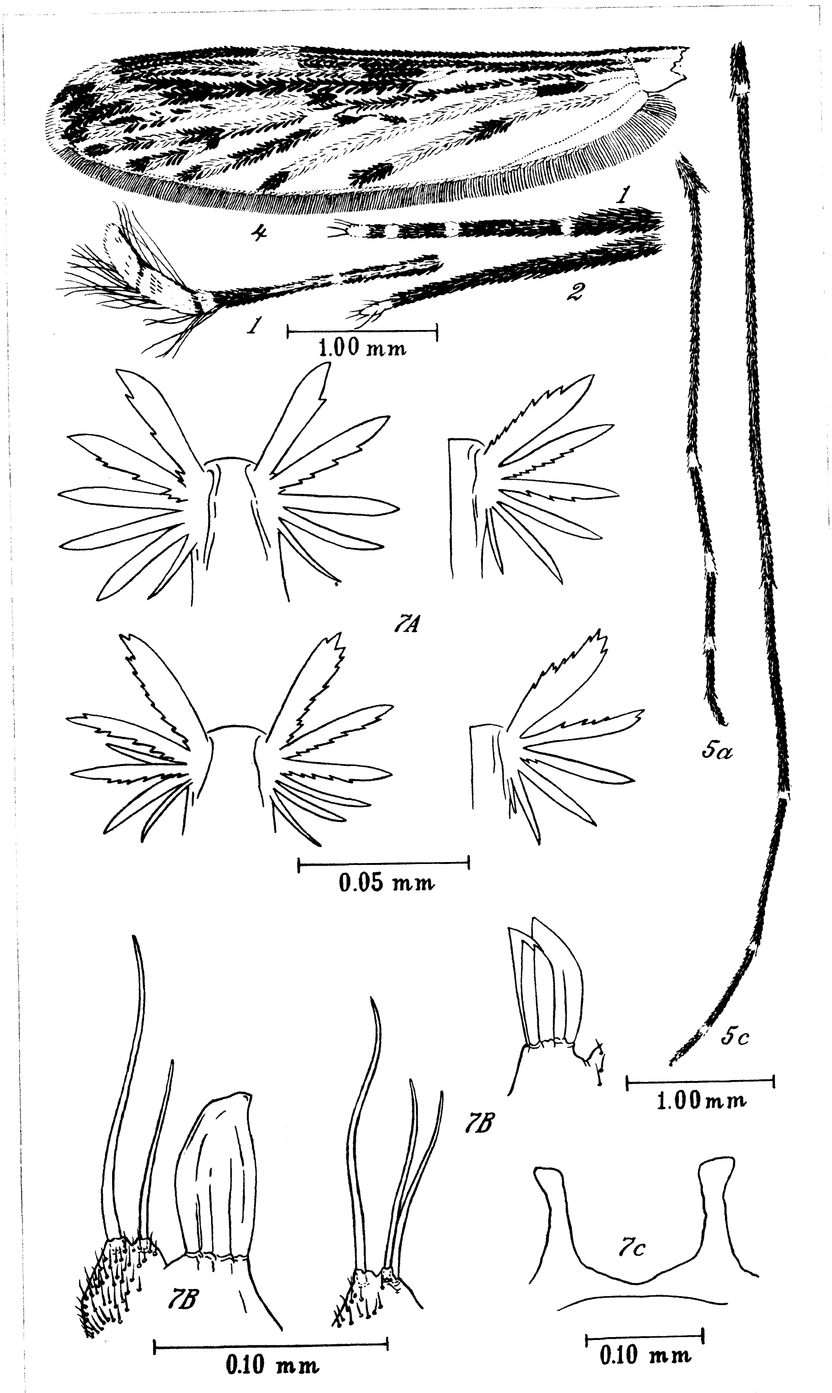

PLATE 8. ANOPHELES HYRCANUS VAR. SINENSIS.

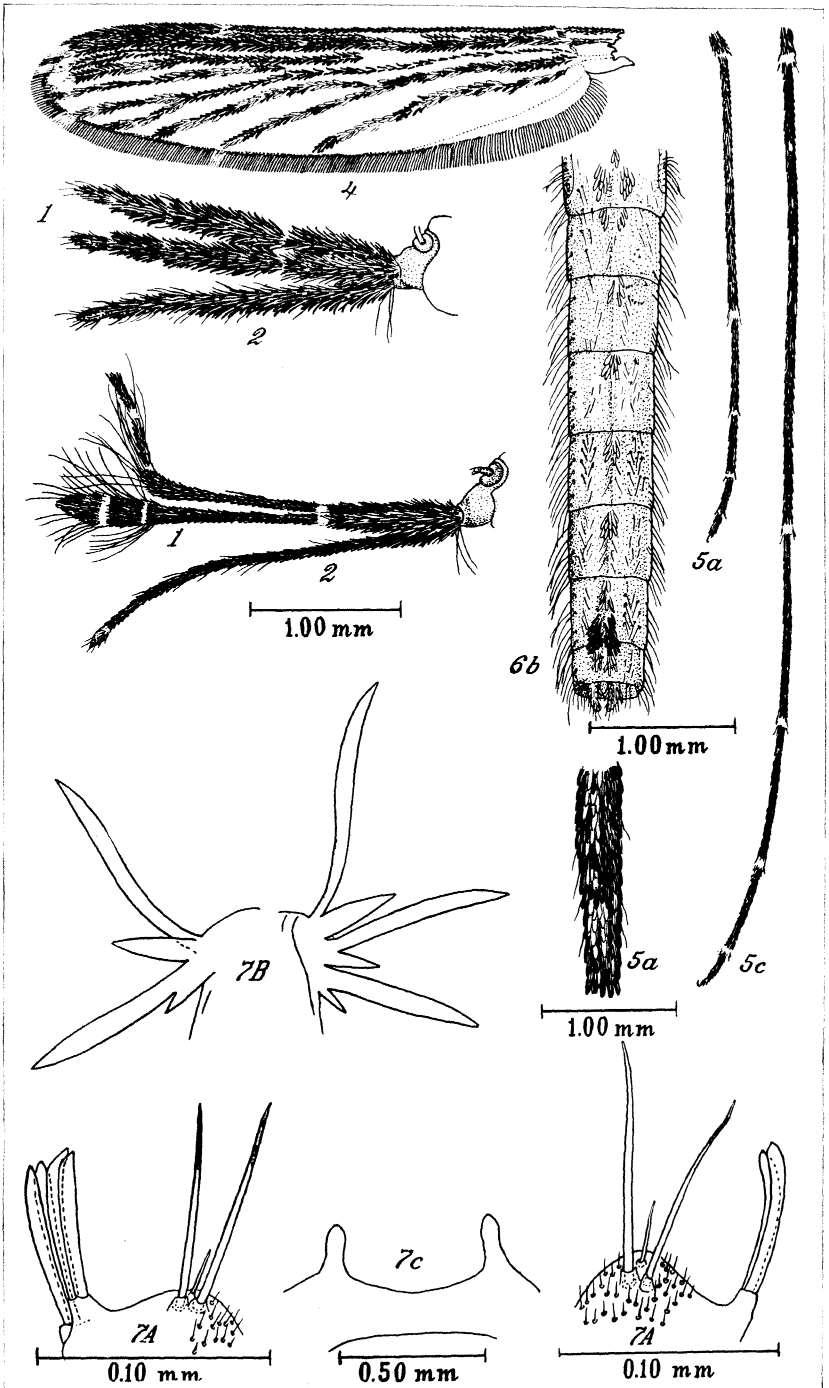

PLATE 9. ANOPHELES PSEUDOBARBIROSTRIS.

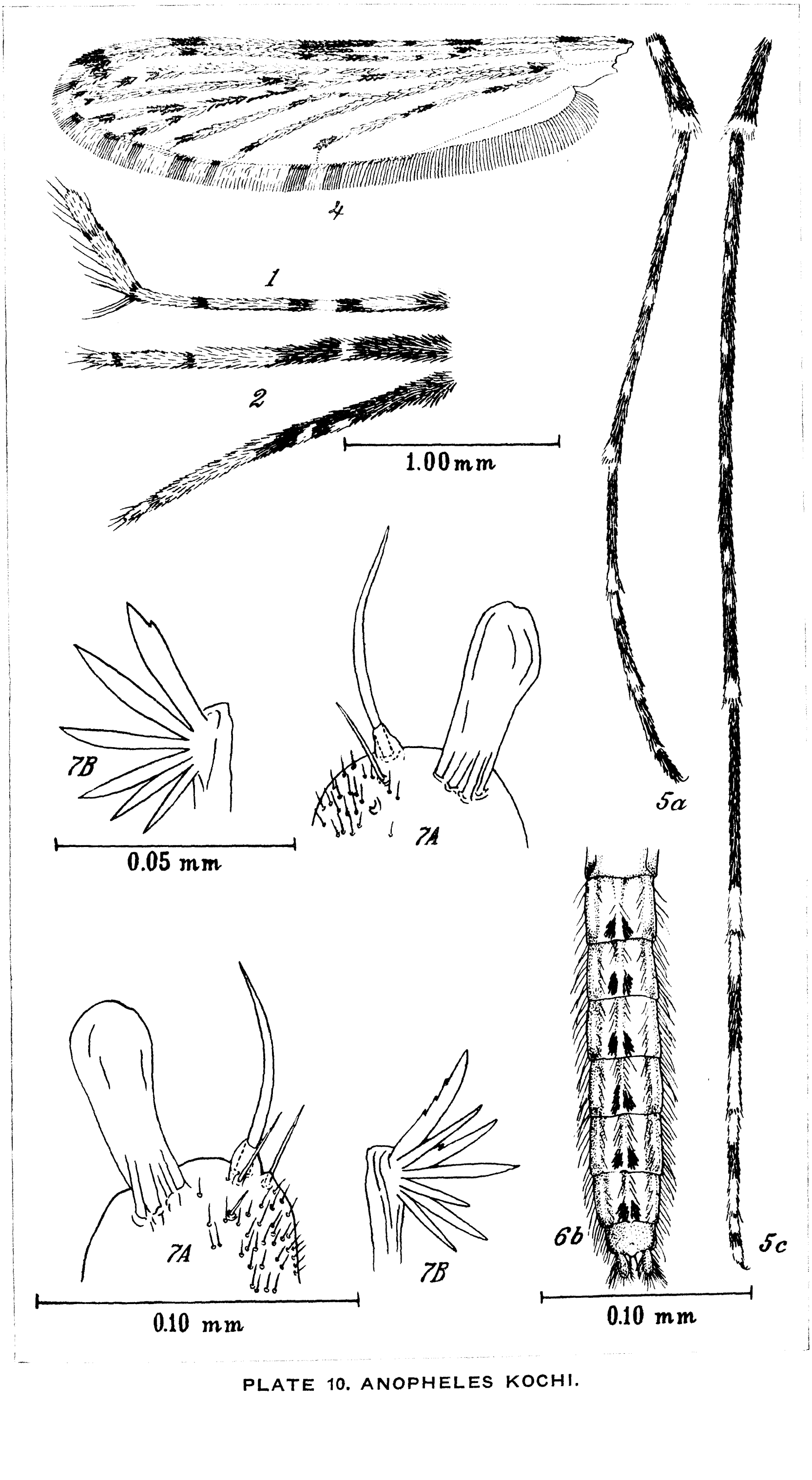

PLATE 10. ANOPHELES KOCHI.

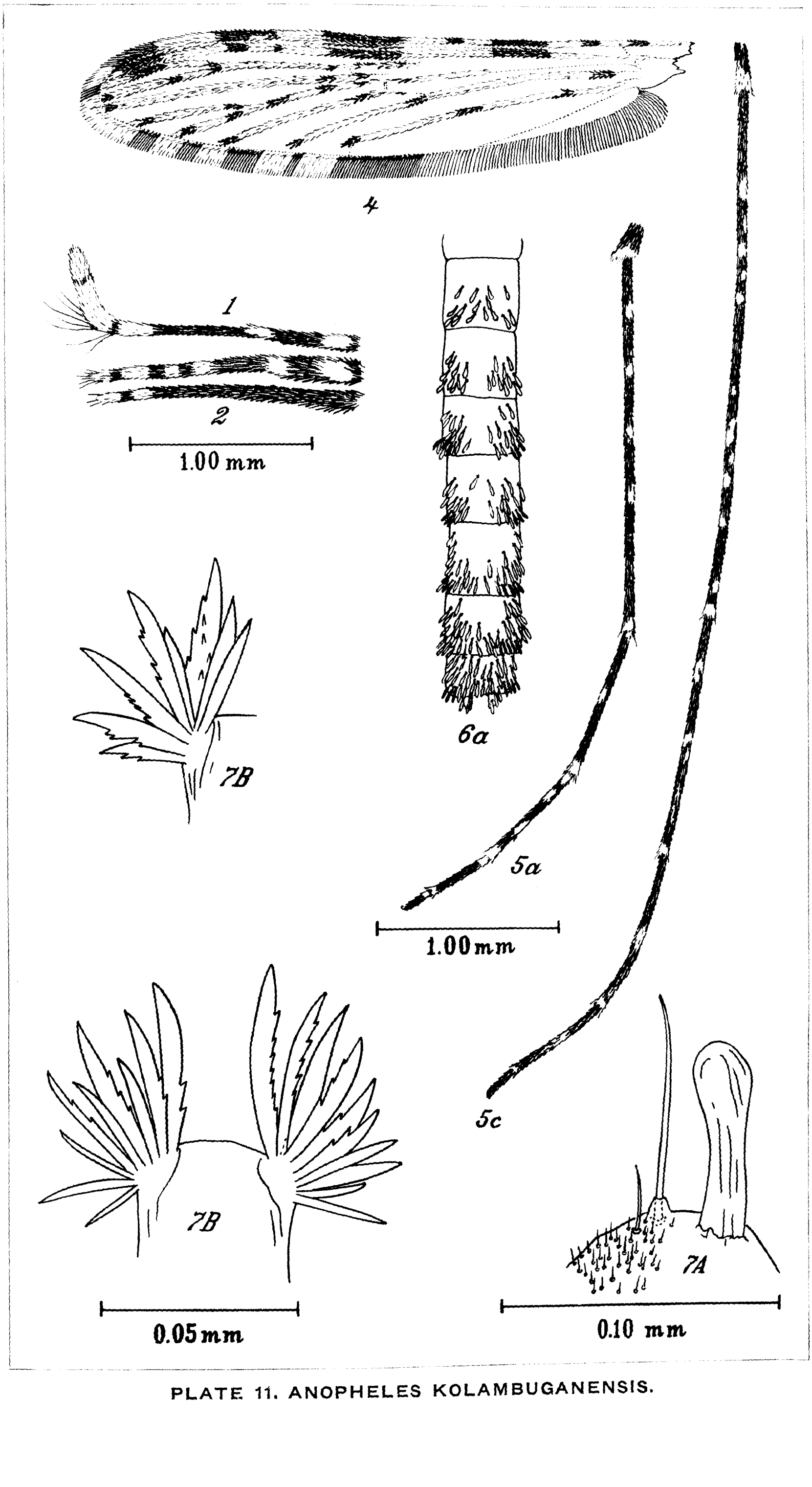

PLATE 11. ANOPHELES KOLAMBUGANENSIS.

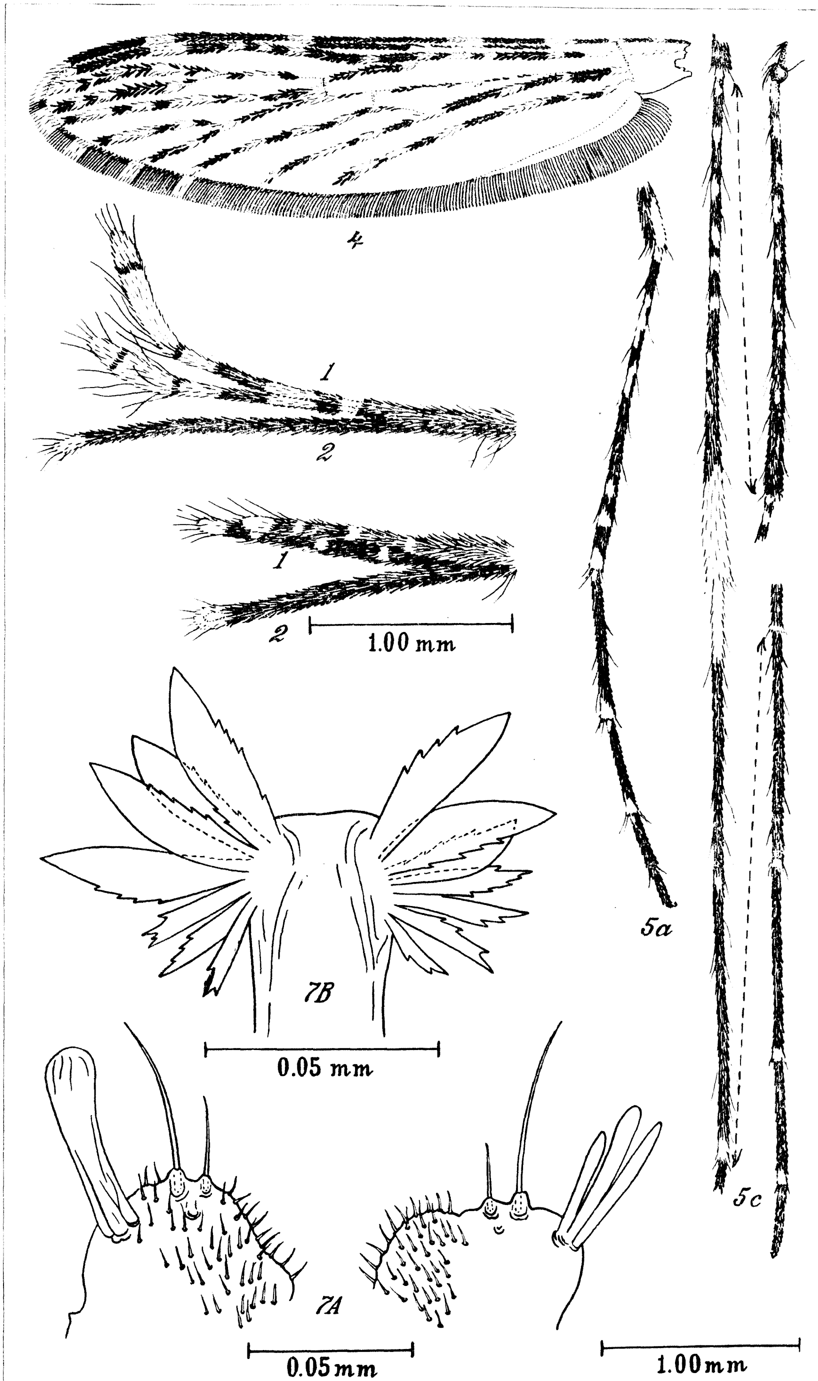

PLATE 12. ANOPHELES LEUCOSPHYRUS.

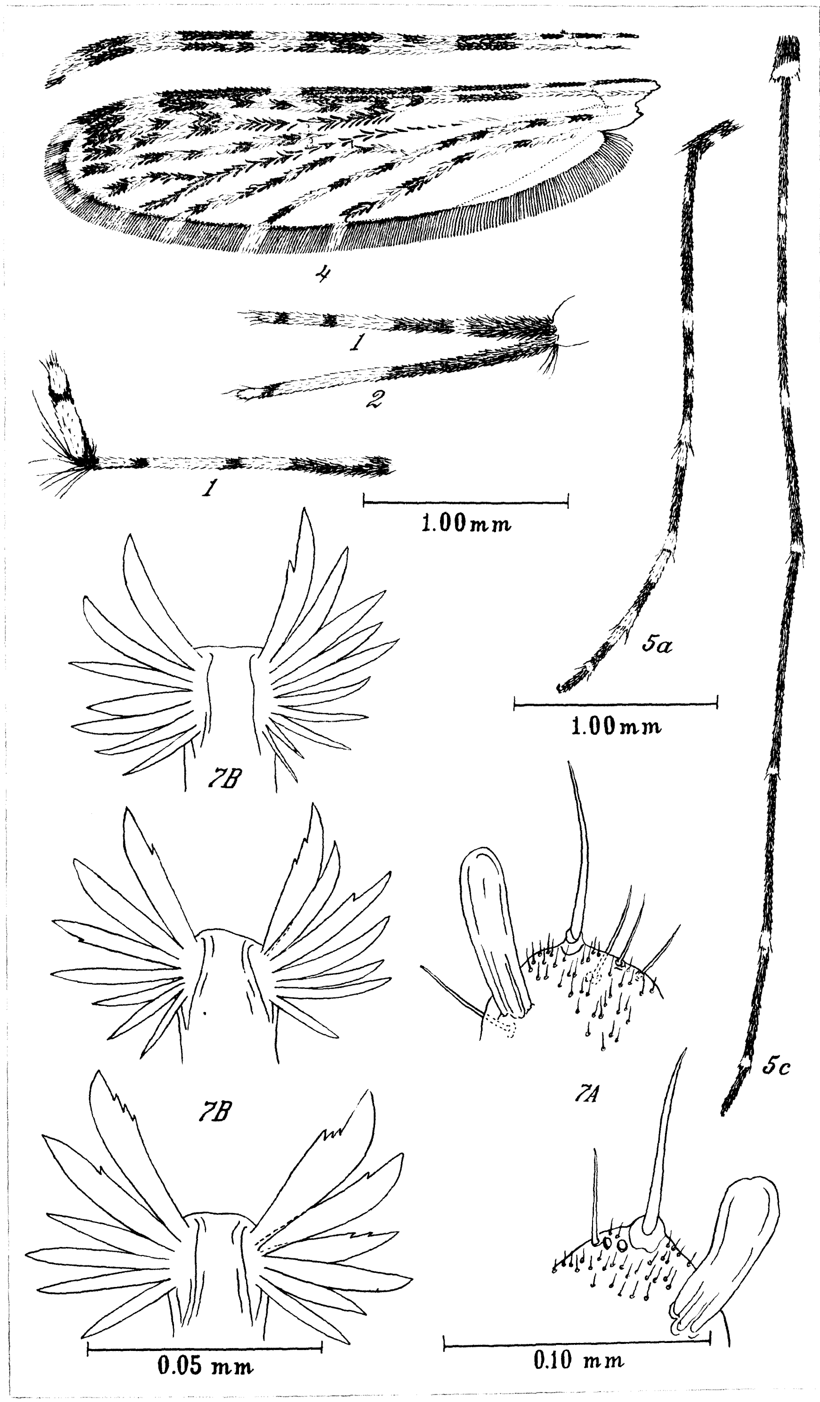

PLATE 13. ANOPHELES TESSELLATUS.

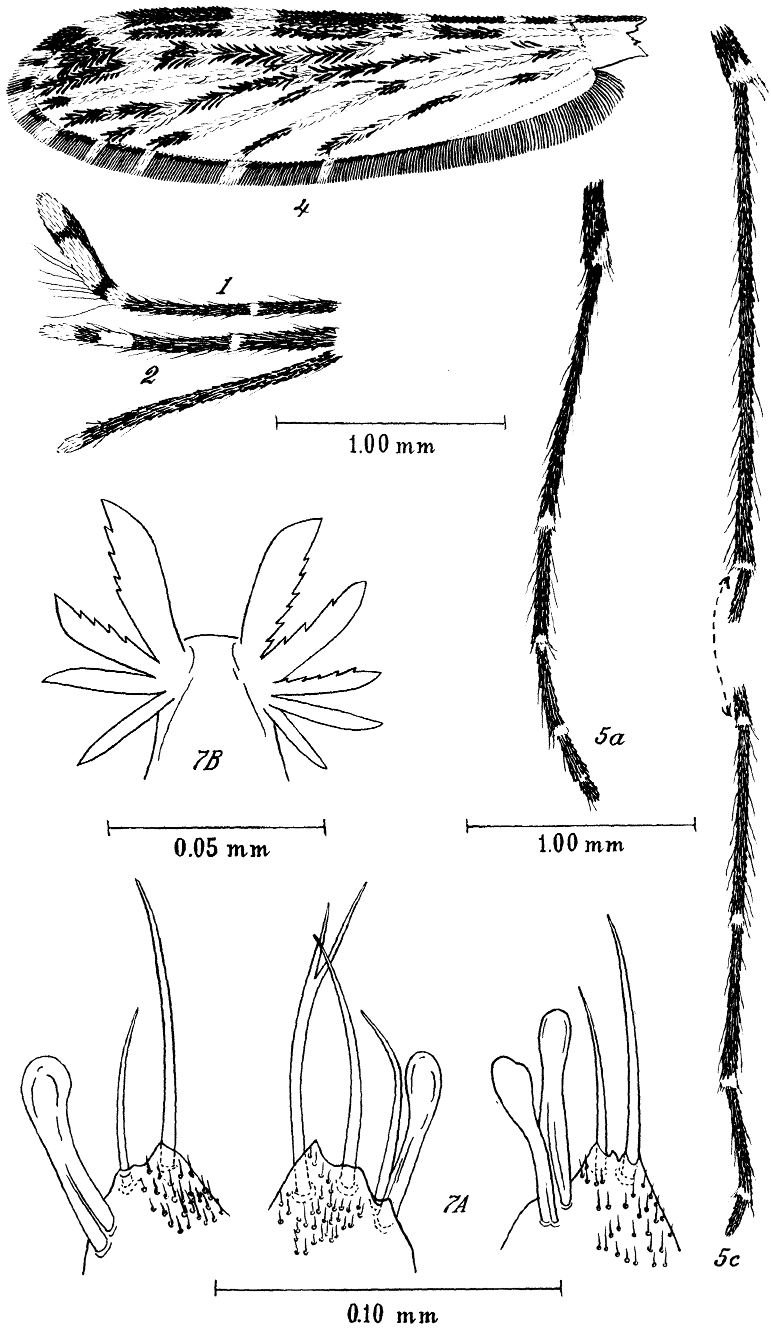

PLATE 14. ANOPHELES FILIPINÆ.

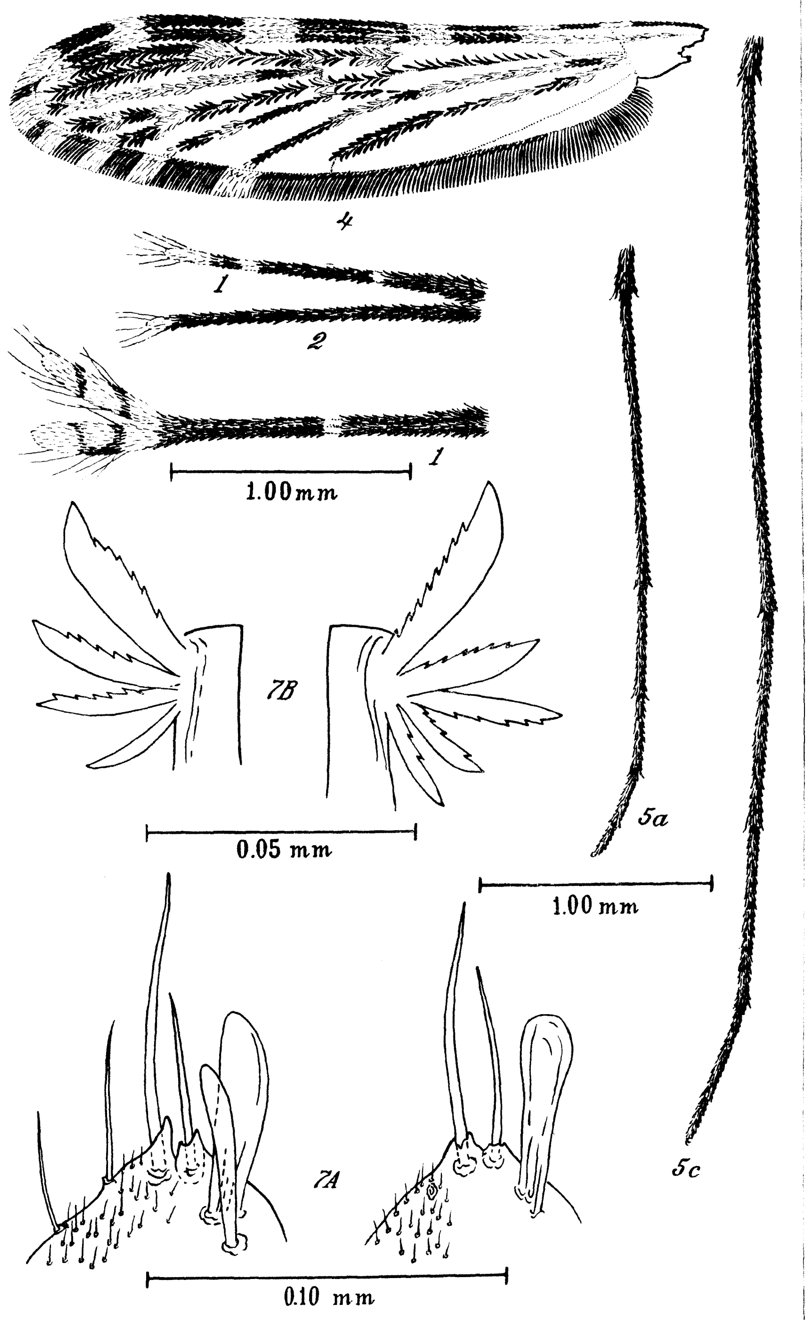

PLATE 15. ANOPHELES MANGYANUS.

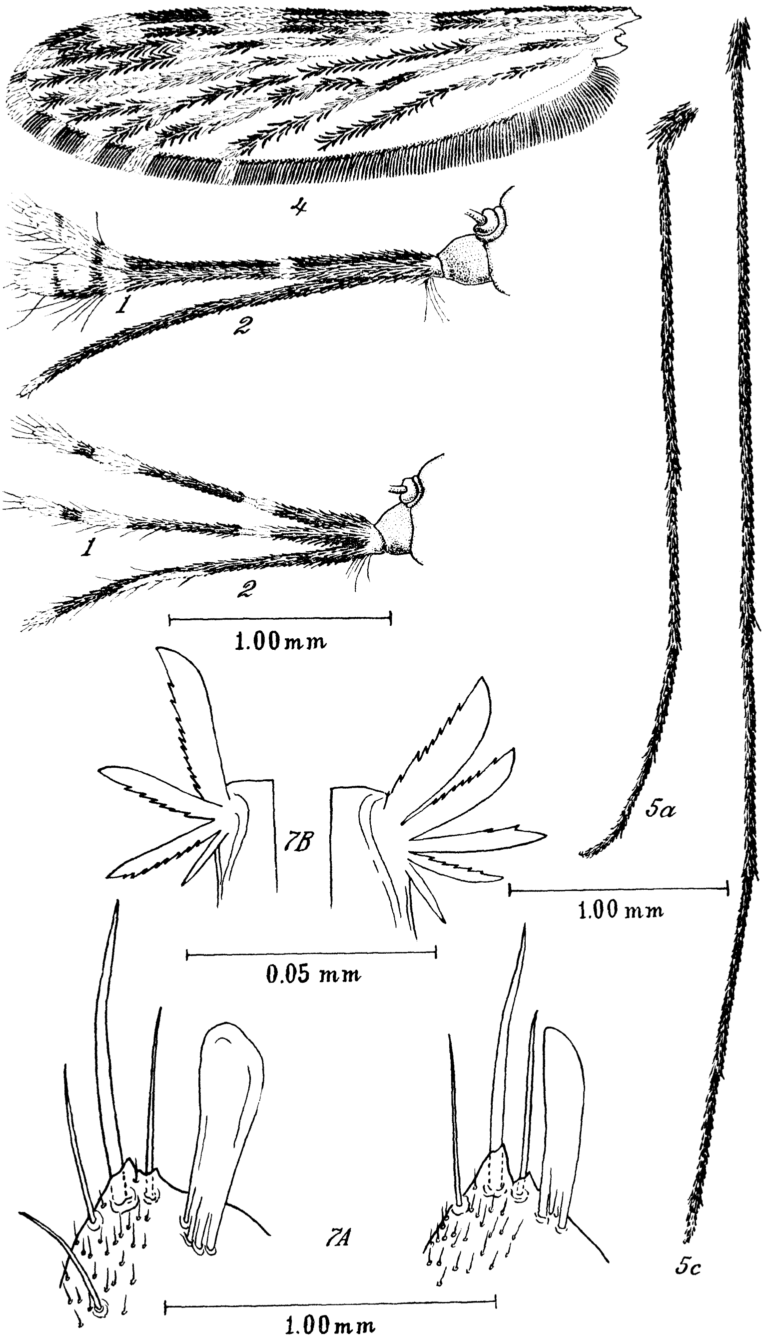

PLATE 16. ANOPHELES MINIMUS VAR. FLAVIROSTRIS.

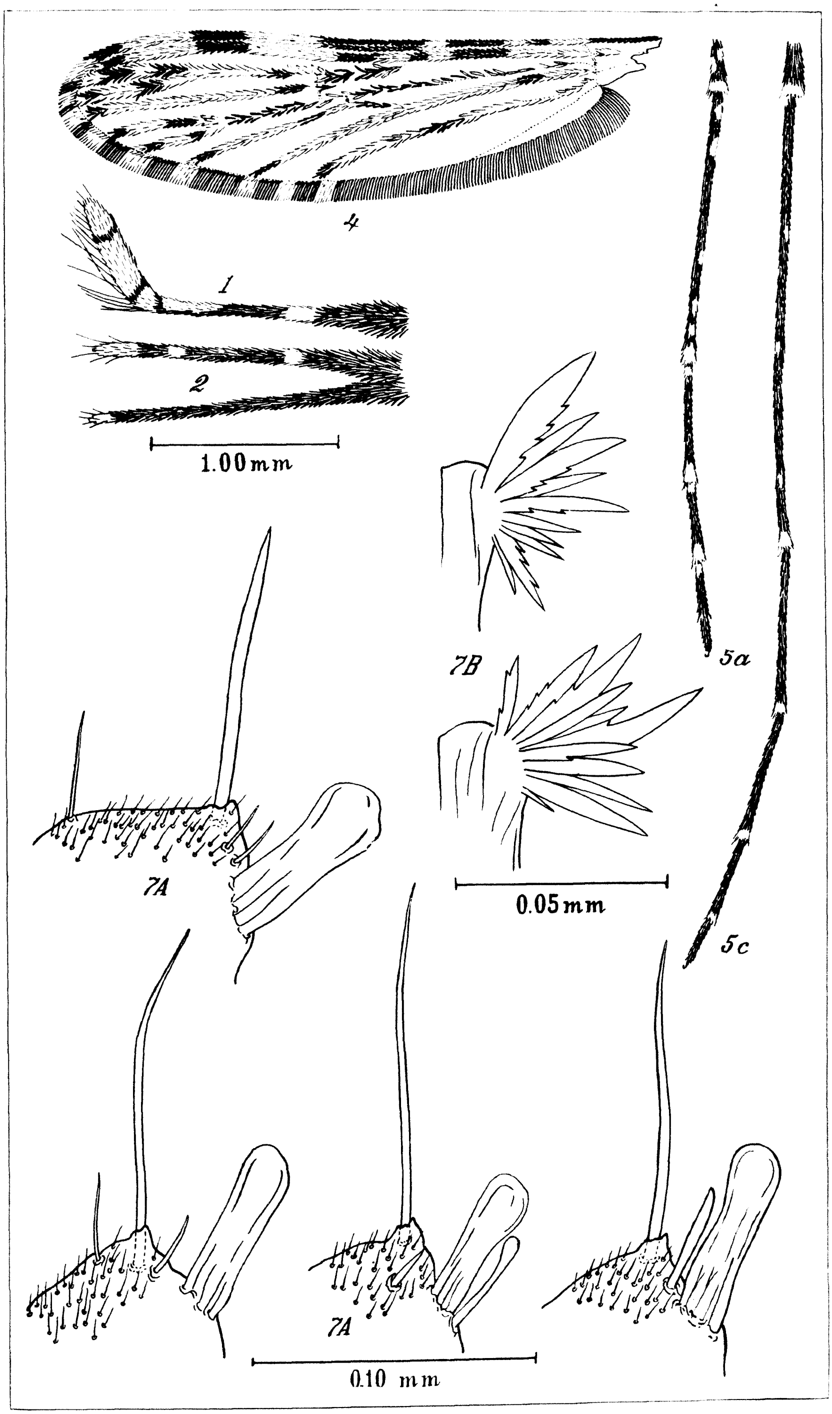

PLATE 17. ANOPHELES LITORALIS.

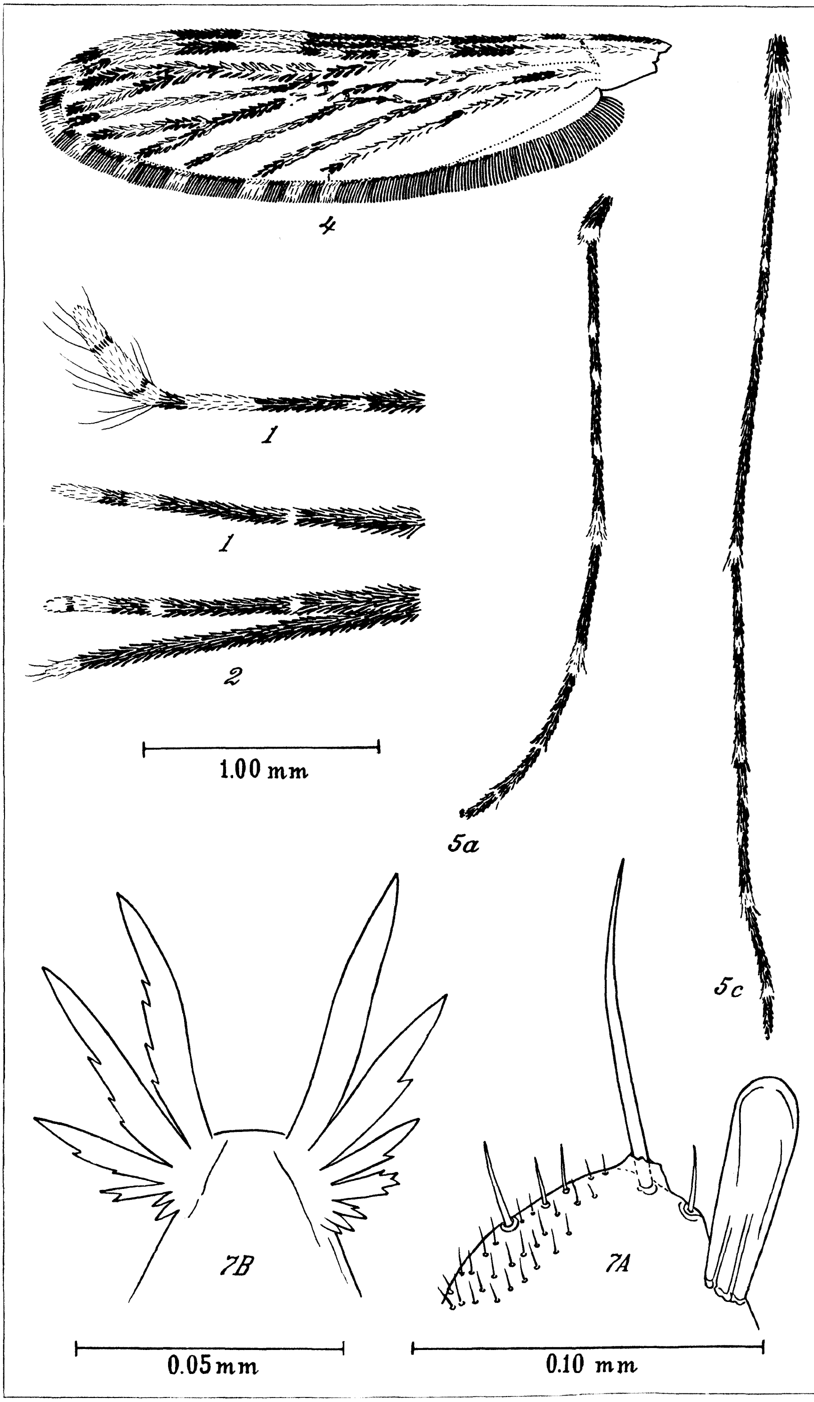

PLATE 18. ANOPHELES LUDLOWI.

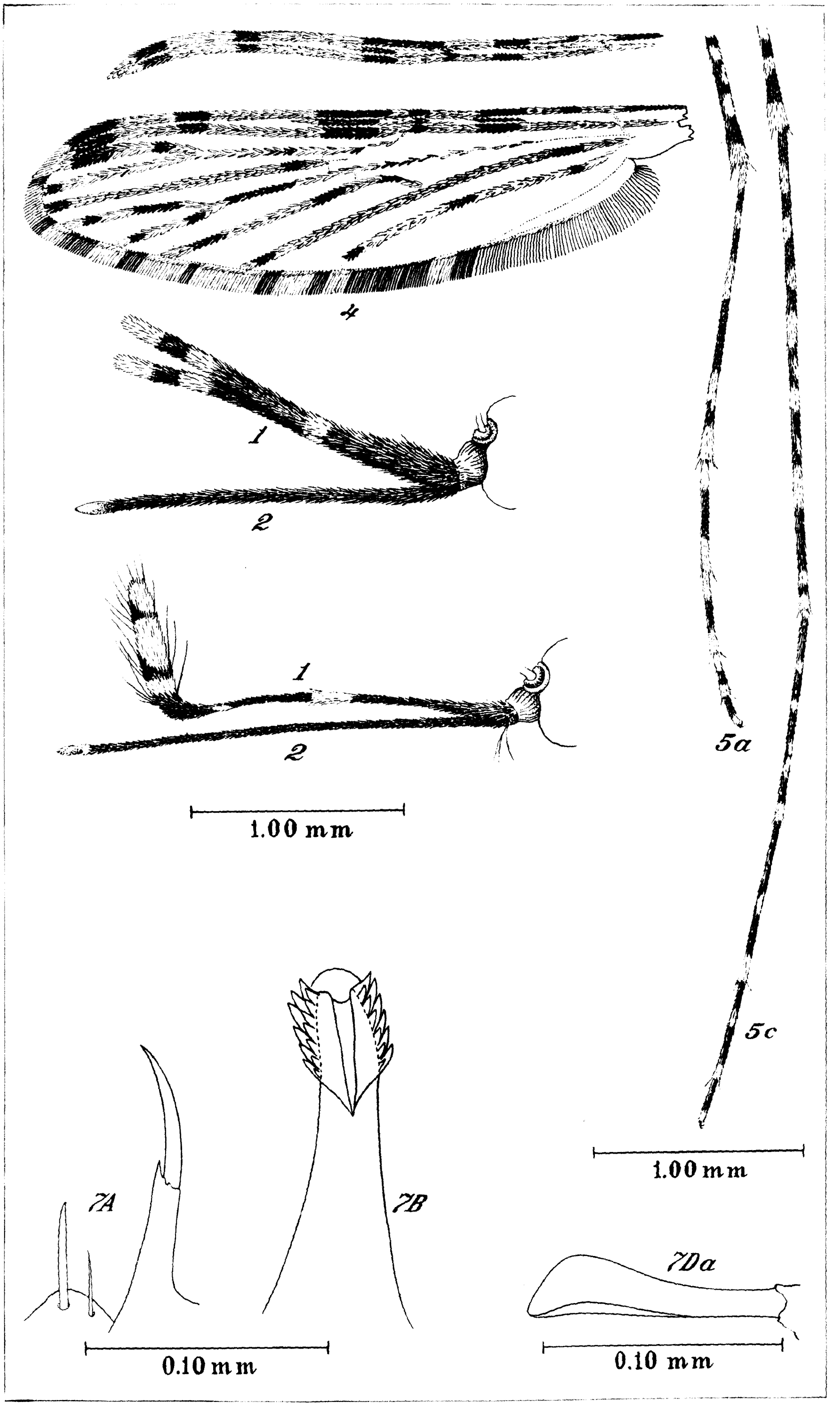

PLATE 19. ANOPHELES PARANGENSIS.

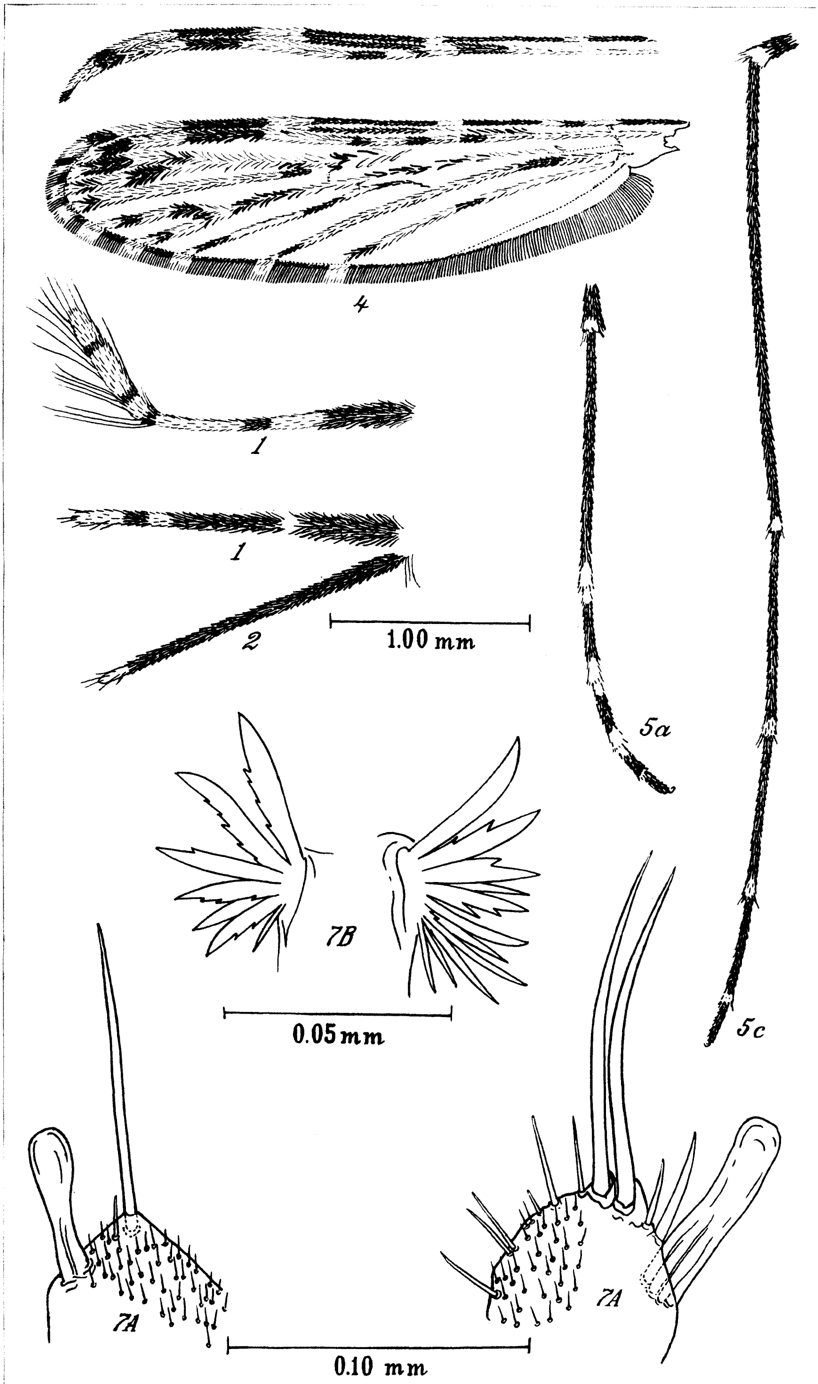

PLATE 20. ANOPHELES SUBPICTUS VAR. INDEFINITUS.

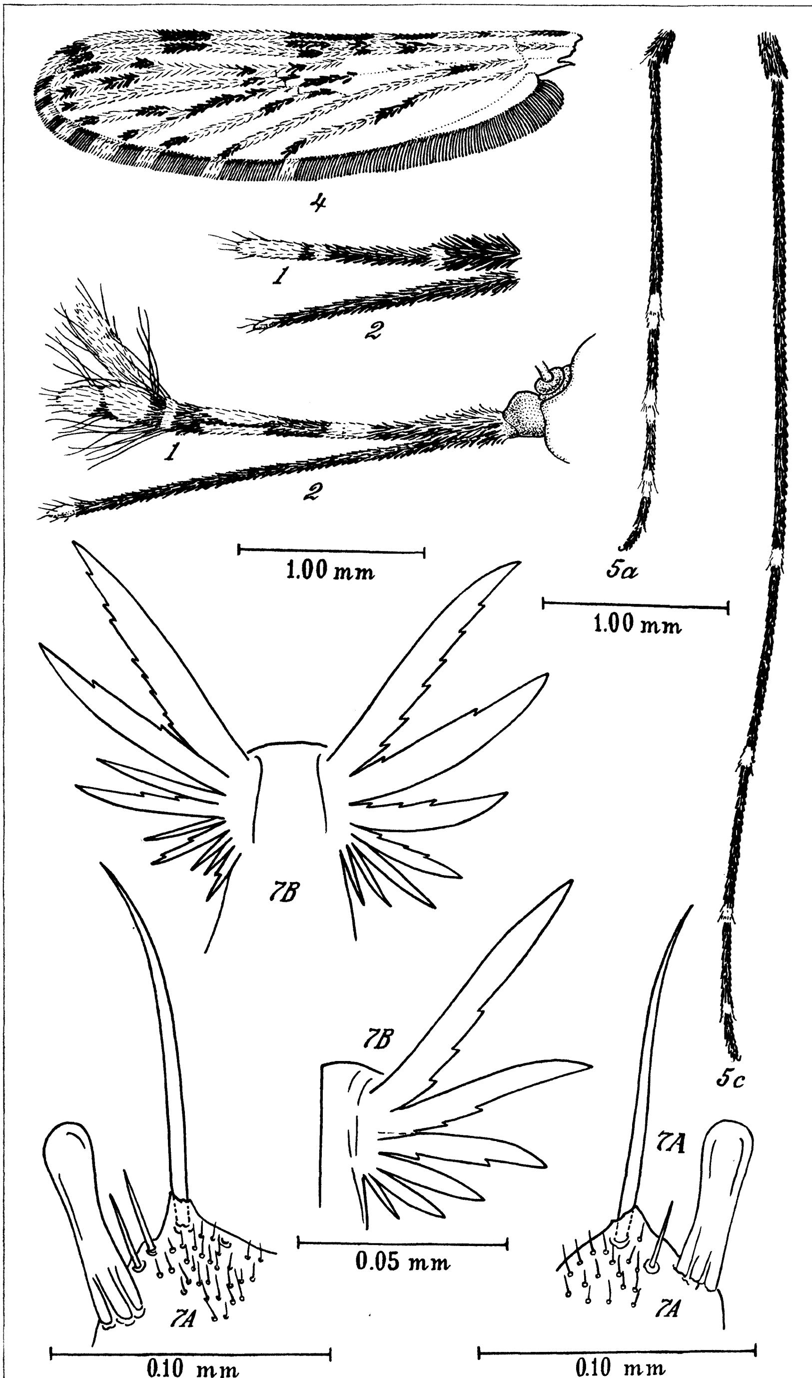

PLATE 21. ANOPHELES VAGUS VAR. LIMOSUS.

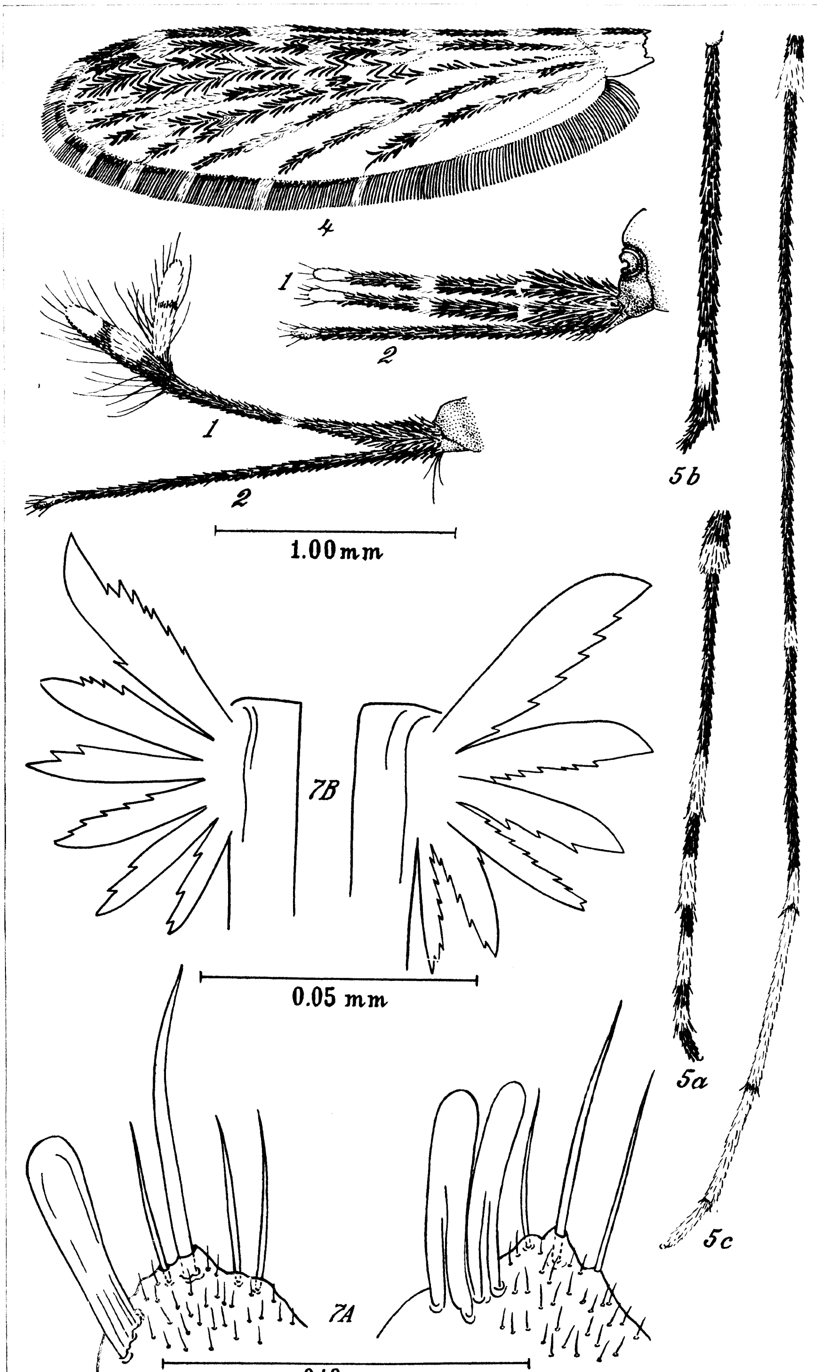

PLATE 22. ANOPHELES ANNULARIS.

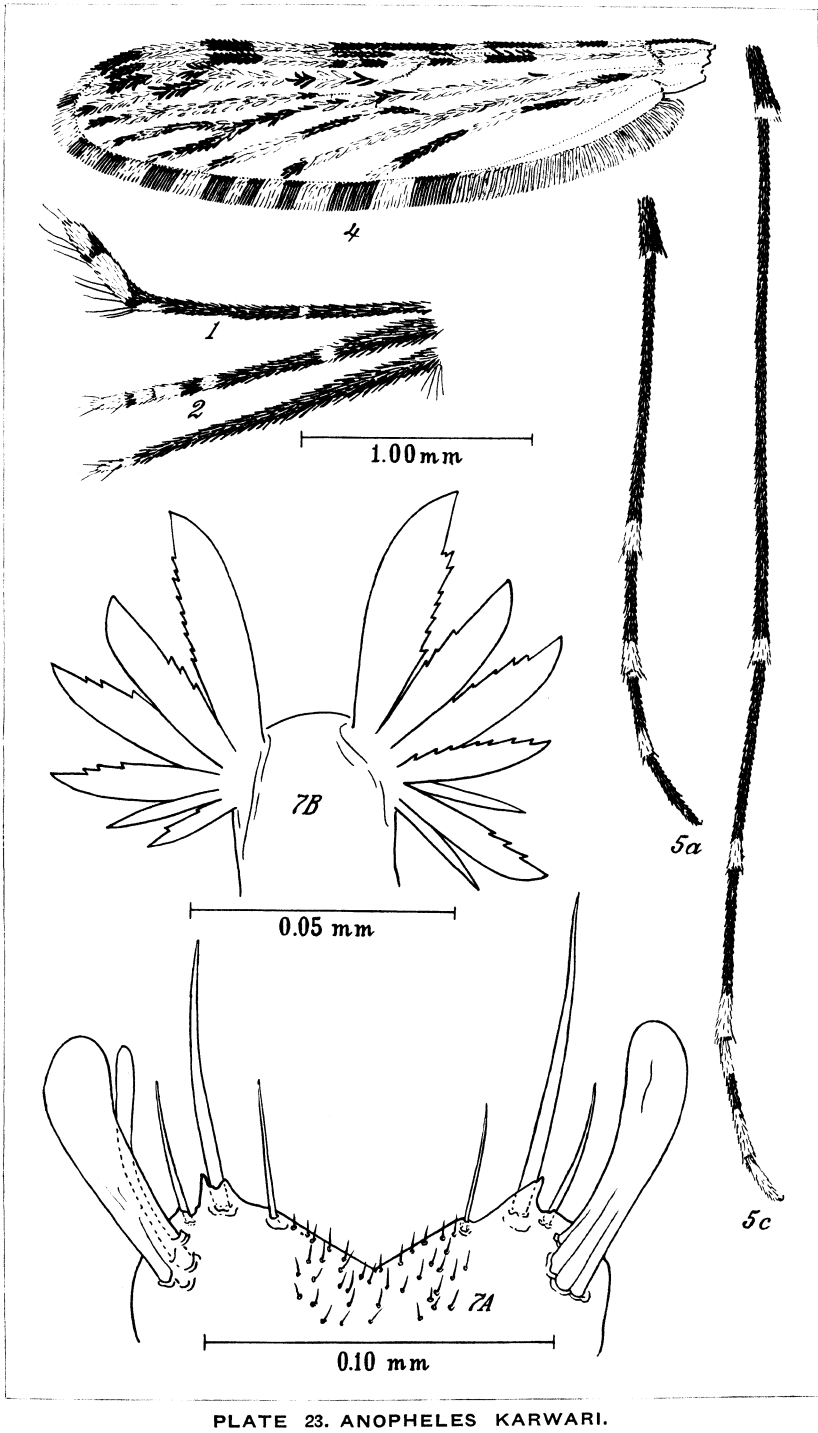

PLATE 23. ANOPHELES KARWARI.

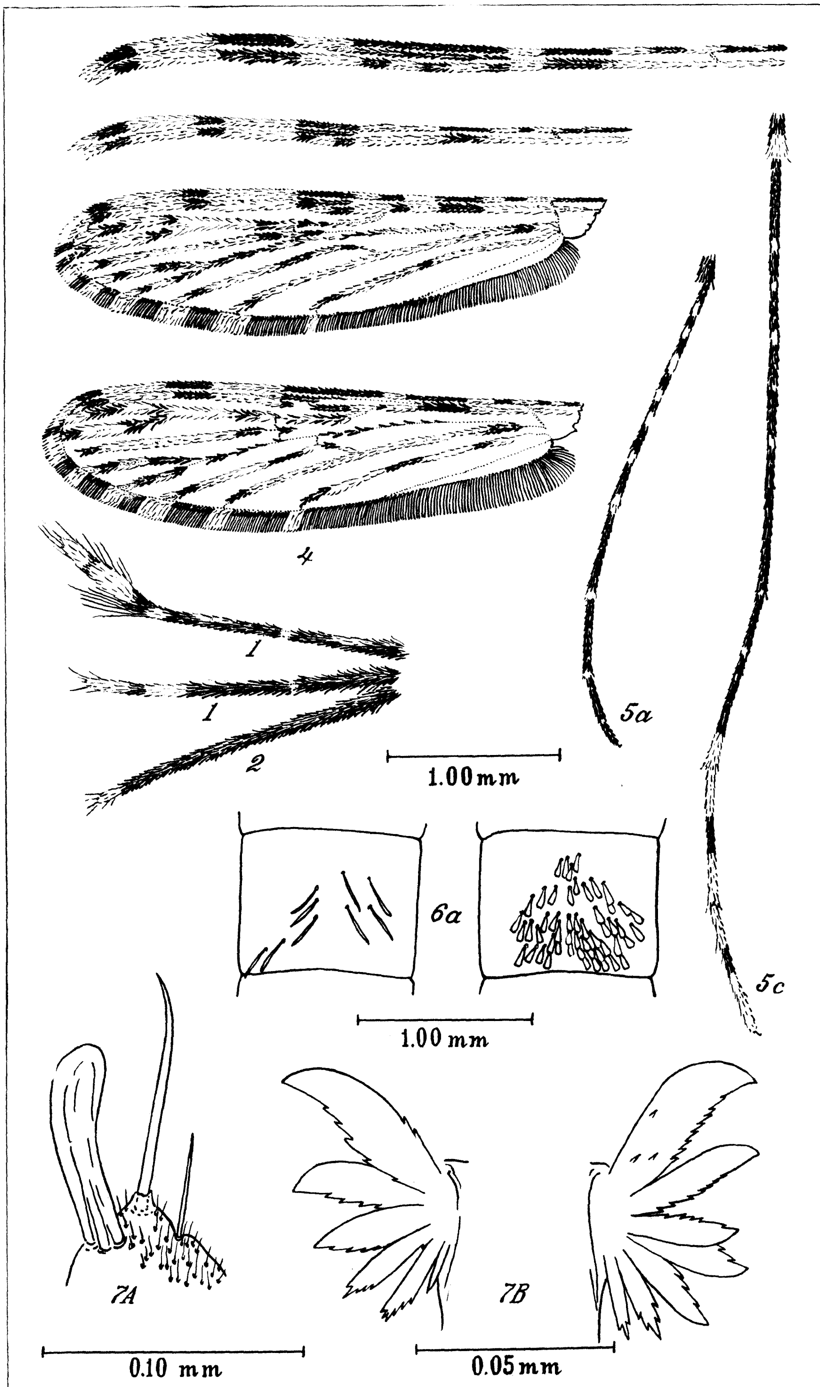

PLATE 24. ANOPHELES MACULATUS.

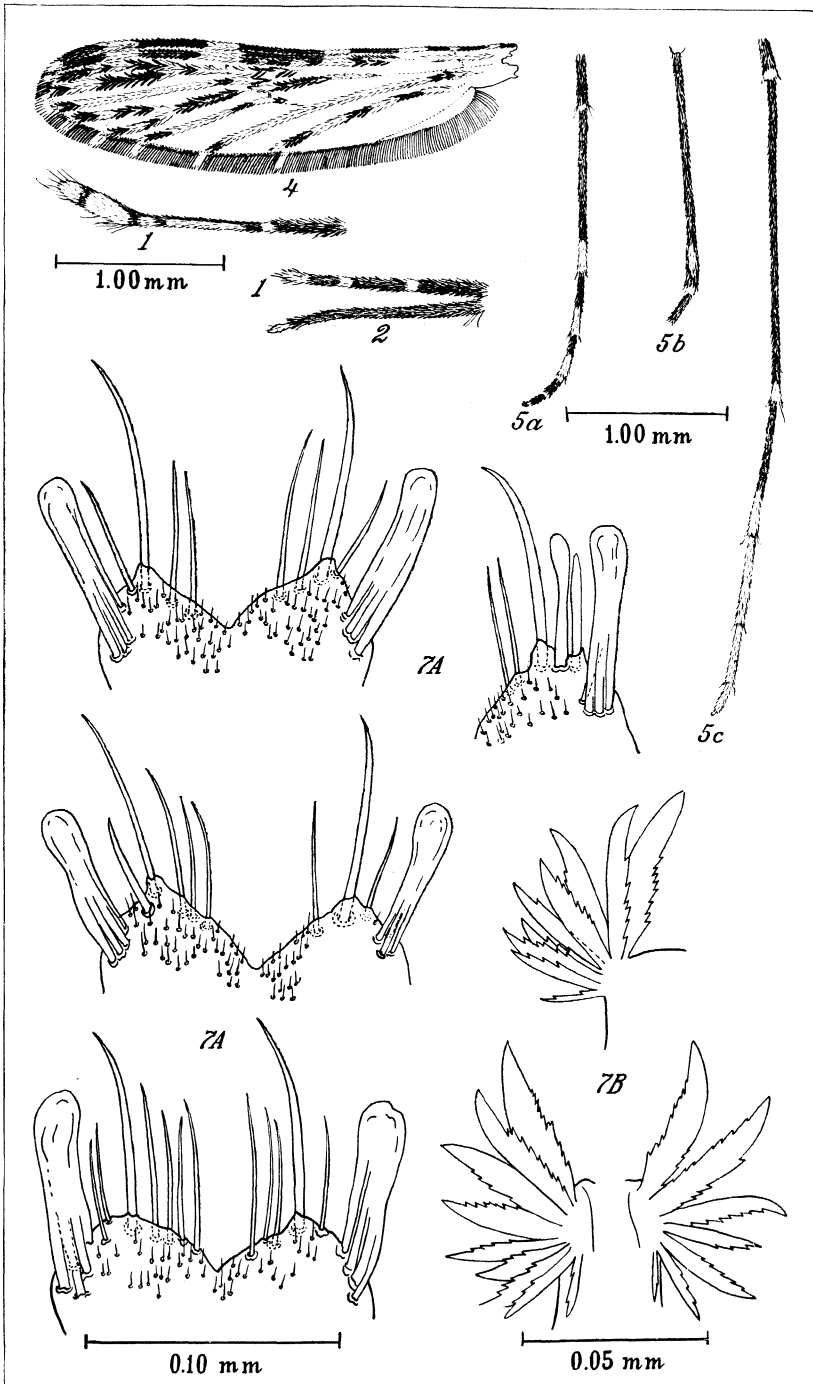

PLATE 25. ANOPHELES PHILIPPINENSIS.

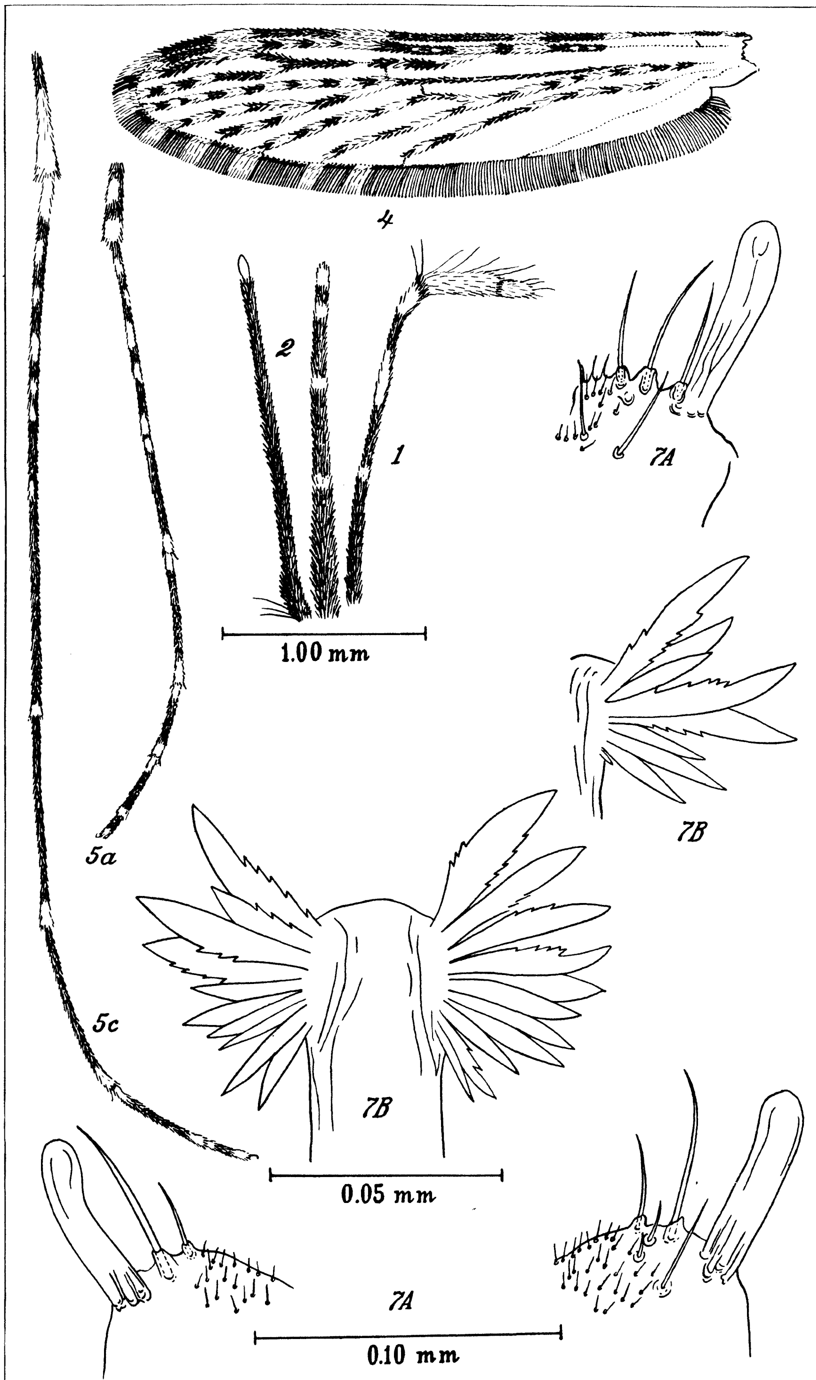

PLATE 26. BALABAC ANOPHELES.

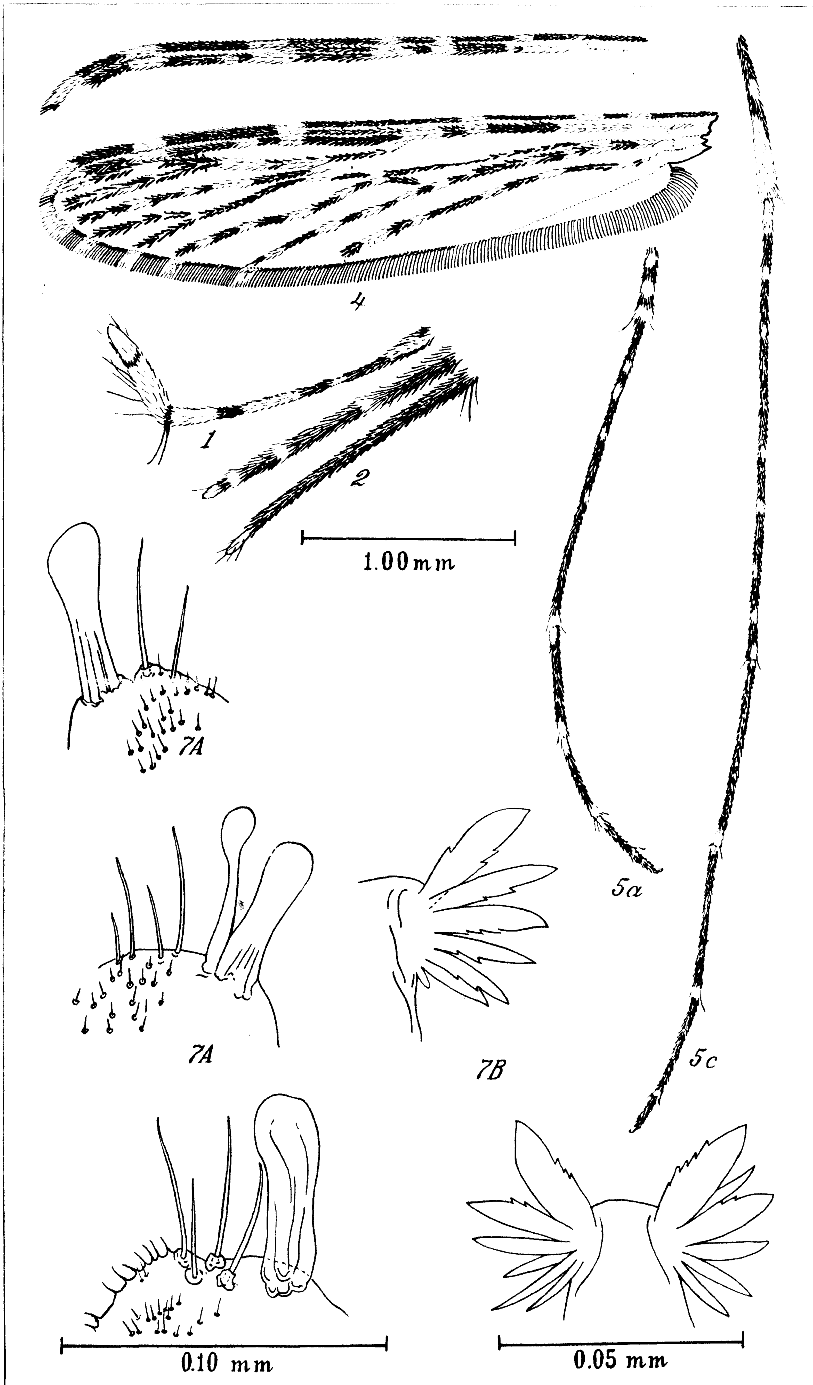

PLATE 27. ANOPHELES NEAR-LEUCOSPHYRUS.

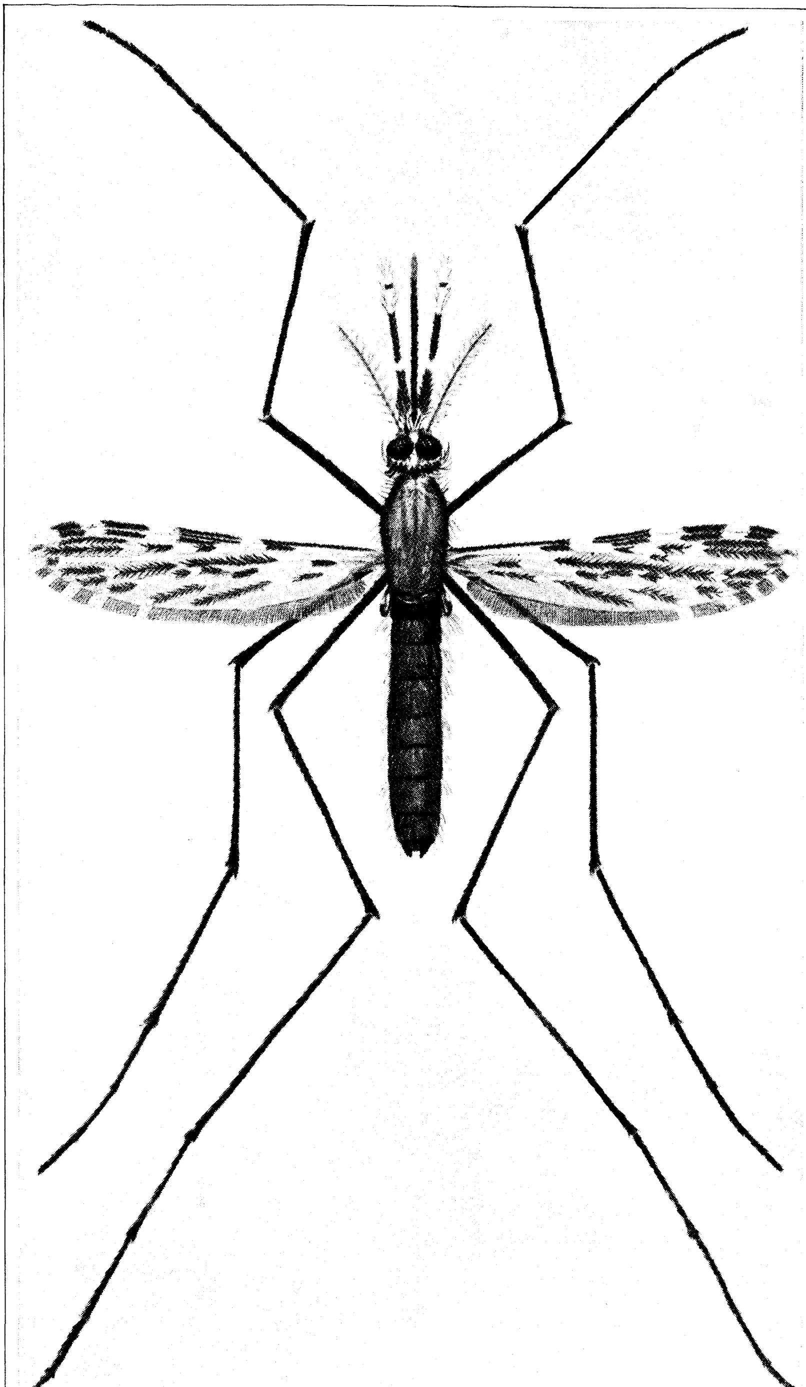

PLATE 28. ANOPHELES MINIMUS VAR. FLAVIROSTRIS.

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PLATE 29.

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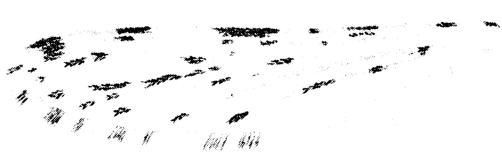

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PLATE 30.

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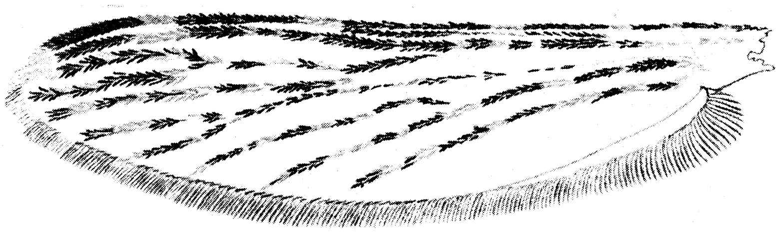

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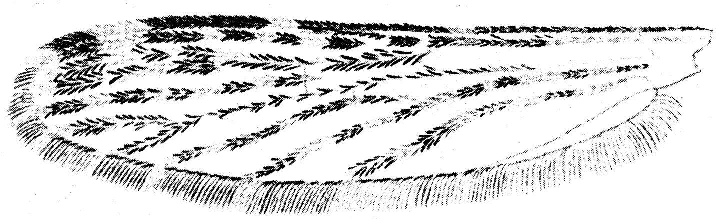

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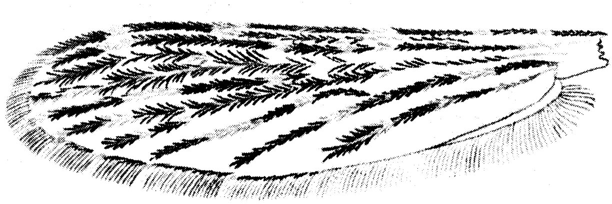

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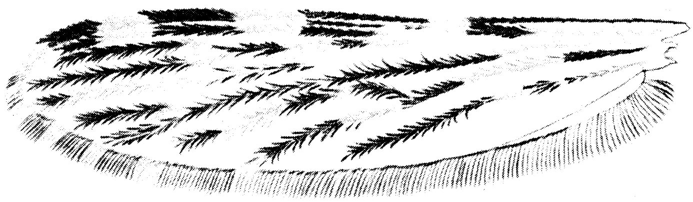
PLATE 31.



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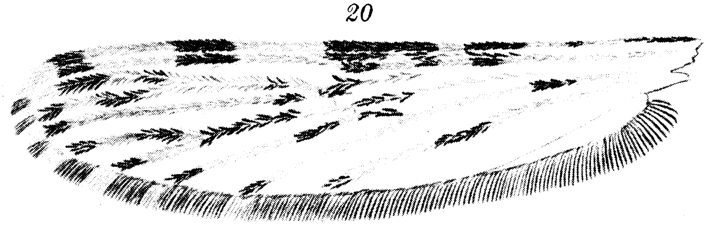

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PLATE 32.

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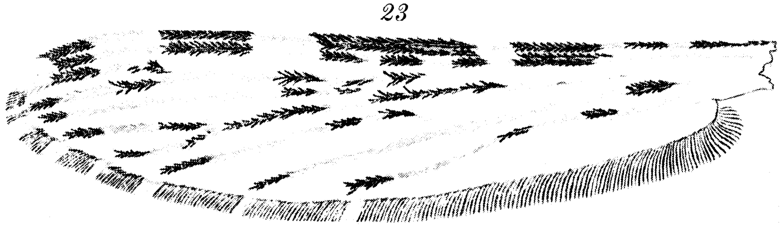

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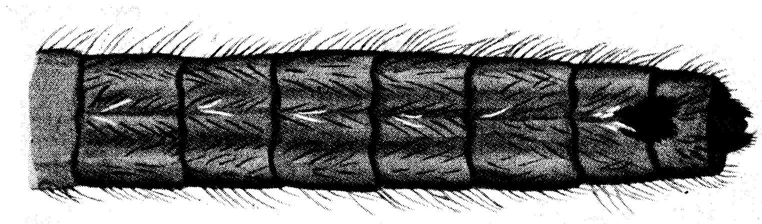
PLATE 33.



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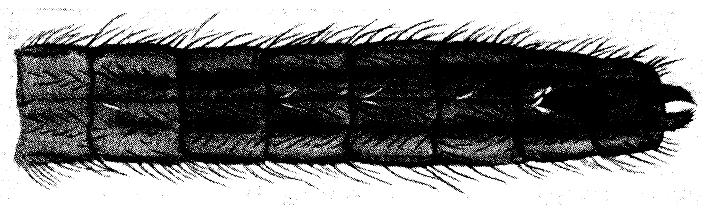

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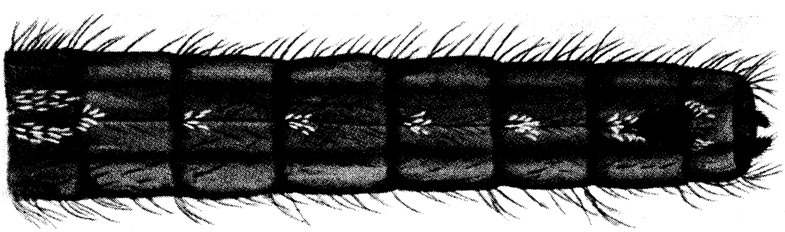

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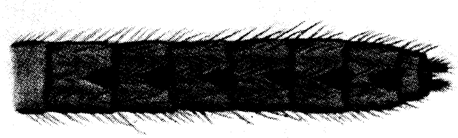

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PLATE 34.

NOTES ON PHILIPPINE MOSQUITOES, IV

THE PUPAL AND CERTAIN ADULT CHARACTERS OF SOME RARE SPECIES OF ANOPHELES [1]

By F. E. BAISAS

Of the Bureau of Health, Manila

FIFTEEN PLATES AND ONE TEXT FIGURE

The present paper is an attempt to discover, if possible, further evidence that will justify the separation into species or varieties of the very closely allied members of certain groups of Philippine anopheles. It also includes other species, which do not belong to any particular group in the local anopheline fauna.

THE LEUCOSPHYRUS GROUP

GENERAL CONSIDERATIONS

There are three forms in this group. One, so far as known, is confined to Mindanao; another seems to be restricted to the western islands and has been reported from Palawan and Balabac. The third was at first known only in Luzon, but was later found in greater numbers in Mindanao.

Except Balabac, I have seen the breeding places of these mosquitoes in all the localities named, and have made the greater part of the collections for Dr. W. V. King and Dr. P. F. Russell. I have observed breeding in Mindanao for three consecutive summers, and the only known breeding place of *leucosphyrus* in Luzon has been under my observation for a number of years. We got the first specimens of this species in 1925.

ANOPHELES LEUCOSPHYRUS var. BALABACENSIS var. nov.

I propose to restrict the name *Anopheles leucosphyrus* Dönitz (1901) to the type represented in Luzon and to use *A. leucosphyrus* var. *balabacensis* var. nov. for the variety found in Palawan and Balabac. The type specimens of this, a male (lot R80–34), a female (lot R80–12), and their corresponding larval skins, together with a number of cotypes, are deposited in the

[1] Submitted for publication May, 1935. Parts of these notes dealing the same subject (1934–1935).

collections of the Bureau of Health, Manila. The type locality is Balabac, Balabac Island. Mr. F. Guinto made the collection in June, 1934. Prior to this Dr. P. F. Russell and Mr. Andres Nono secured several larvæ of this mosquito from the same locality, from which, however, no adult emerged.

Anopheles near-*leucosphyrus*, cumbersome and awkward as it is, has to be used until Dr. W. V. King himself has the chance to change it. The very first specimens of this species were given to him. Unfortunately he left the Philippines without having the opportunity to work on them, and could only assign the provisional designation by which the species is now known.

In breeding habits near-*leucosphyrus* is distinct. It was once found breeding in a tree hole, the only instance of this kind among anopheles in the Philippines. Moreover, it consistently breeds in rock holes, and has not been found in any other situation although there are nice nooks along the edges of the creek, which look very much like rock holes. Undoubtedly it will breed in any other creek where similar conditions exist, but it is rather strange that in the considerable forest area and the numerous streams that I have seen in Mindanao only one creek was found harboring near-*leucosphyrus*. Judging from its very limited range of breeding habits, it may be supposed that this species will be exterminated by the rapid deforestation that is taking place in the locality where it breeds. It has not been found breeding heavily at any one time.

Anopheles leucosphyrus, as found in Luzon and Mindanao, breeds in rock holes and in quiet corners of forest creeks; but it seems best suited to larger stagnated portions of forest streams and even rivers with plenty of débris and well shaded by trees. In the last type of situation I have found it breeding in numbers reaching a hundred larvæ on more than one occasion and in more than one stream. In Luzon it has been known to breed very scantily. At only one time—January 7, 1935—have I found more than twenty larvæ in a single stagnated portion of the creek where it breeds. Usually only one to six larvæ can be found in the whole creek at any one time. In both Luzon and Mindanao breeding of *leucosphyrus* is markedly seasonal.

A kind of larva that is intermediate in character between near-*leucosphyrus* and *leucosphyrus* has been found two or three times breeding with near-*leucosphyrus* in rock holes. I have not, however, succeeded in obtaining adult males from such larvæ. It would be interesting to find out if such intermediate peculiarities signify anything at all in the adult.

Anopheles leucosphyrus var. *balabacensis* is closest to the *leucosphyrus* of other countries in breeding habits. It has been found in quiet corners of forest creeks, in clear pools left in beds of temporary forest streams, and in open forest pools away from streams. It seems to be the heaviest breeder of the three forms.

THE LARVÆ

For larval characters and differentiation between the forms, the reader is referred to Russell and Baisas's paper.[2]

THE PUPÆ[3]

Variations in the branching of the pupal hairs are considerable. Even in single individuals the hairs on one side vary greatly from those on the other. However, certain characters have been found useful in differential diagnosis of the forms under the group. Spine *A* of abdominal segments II to VI of *leucosphyrus* is always simple; that on VII may sometimes be branched. In near-*leucosphyrus* and in var. *balabacensis* this spine is usually branched on segments V to VII. Occasionally even that on IV is branched. In some instances one or more of these spines on one or more segments may be simple, but the majority have been found branched. Hair *B* of abdominal segments V to VII is usually less branched in var. *balabacensis* than in either of the other two forms. To separate var. *balabacensis* from near-*leucosphyrus* two or three characters may be used. The respiratory trumpets of near-*leucosphyrus* are narrower than those of var. *balabacensis*. Hair *O* of the metathorax in var. *balabacensis* is usually less branched than that in near-*leucosphyrus*, while hair *C* of abdominal segment II often has more branches in *balabacensis* than in near-*leucosphyrus*. The branches of this hair in near-*leucosphyrus* are arranged generally in one plane like a fan, whereas those in the other two

[2] Philip. Journ. Sci. 55 (December, 1934). Plates 14, 27, and 28 of that paper illustrate the typical forms and Plate 29, fig. F, shows the intermediate type.

[3] The nomenclature employed in this paper for pupal characters is in accordance with Senevet (1930, pp. 71–74), as modified by Christophers (1933, pp. 32–34). Plates 1 and 2 show the designation of parts. In the drawings the scalelike coverings of the inner and outer surfaces of the respiratory trumpets have been omitted. A pair of very short hairs is present on the anterior part of the ventral side on segments IV to VIII of the abdomen. I refer to these as hair 9. Senevet (1932) designates them by the symbol ξ.

TABLE 1.—*Pupal characters in the Anopheles leucosphyrus group.*

	Hairs.	*Anopheles leucosphyrus.*				*Anopheles leucosphyrus* var. *balabacensis.*				*Anopheles* near-*leucosphyrus.*			
		Number examined.	Range of branches.	Average branches.	Commonest branches.	Number examined.	Range of branches.	Average branches.	Commonest branches.	Number examined.	Range of branches.	Average branches.	Commonest branches.
Metathorax	R	16	1- 2	1.4	1	19	1- 3	2.2	2	24	2- 6	3.3	3
Do.	P	15	1- 3	2.0	2	19	1- 4	2.9	3	24	2- 4	2.5	2
Do.	O	16	1- 4	2.1	2	20	2- 6	2.0	2	21	4-10	5.6	5
Abdominal segment I	H	14	1- 1	1.0	1	20	1- 2	1.0	1	23	1- 3	1.9	2
Do.	K	11	4- 7	6.0	7	19	4- 8	6.0	6	22	5- 9	6.0	6
Do.	L	16	1- 6	3.8	4	20	3- 7	4.9	5	23	3- 7	4.3	4
Do.	M	15	1- 4	2.1	2	20	3- 5	3.6	3	23	2- 5	3.4	3
Do.	S	16	2- 4	2.8	3	20	3- 5	4.2	4	23	2- 6	3.9	3
Do.	T	16	1- 2	1.1	1	20	1- 3	2.0	2	24	1- 3	2.3	3
Do.	U	16	1- 1	1.0	1	20	1- 1	1.0	1	24	1- 1	1.0	1
Abdominal segment II	A	Very tiny, blunt.				Very tiny, blunt.				Very tiny, blunt.			
Do.	C	14	14-27	17.1	18	19	16-43	25.1	25	22	7-16	11.4	11
Do.	1	16	1- 2	1.5	2	19	1- 3	1.9	2	22	1- 3	1.5	1
Do.	1	16	2- 4	3.0	3	18	3- 5	3.6	4	20	3- 6	4.8	5
Do.	2	16	2- 3	2.1	2	20	2- 6	3.9	4	23	1- 3	2.3	2
Do.	2	14	2- 5	3.4	4	18	5- 6	5.4	5	22	4- 8	5.1	5
Do.	3	16	2- 4	2.9	3	19	2- 6	3.1	3	23	2- 6	3.3	3
Do.	4	14	3- 5	3.4	3	20	5- 7	5.6	6	21	4- 7	4.5	4
Do.	5	16	1- 1	1.0	1	20	1- 1	1.0	1	21	1- 1	1.0	1
Abdominal segment III (dorsal)	A	Tiny, blunt				Tiny, blunt				Tiny, blunt.			
Do.	B	13	4- 6	5.1	5	20	8-12	9.3	9	22	6-12	7.5	7
Do.	C	15	4- 8	5.4	5	20	7-11	8.3	8	23	6-17	8.7	7
Do.	1	16	1- 2	1.3	1	20	1- 3	2.1	2	23	1- 3	1.7	2
Do.	2	14	2- 5	3.1	3	20	3- 6	3.9	4	23	2- 5	3.7	4
Do.	3	16	2- 4	2.9	3	17	3- 6	3.7	4	24	2- 9	4.0	4
Do.	4	15	3- 5	4.0	4	20	5- 7	5.6	5	24	2- 6	4.0	4
Do.	5	16	1- 1	1.0	1	20	1- 1	1.0	1	24	1- 1	1.0	1

Abdominal segment III (ventral)	E	4	2- 3	2.1	2	8	2- 4	2.2	2	7	2- 3	2.3	2
Do.	6	4	1- 2	1.9	2	8	2- 3	2.5	3	8	2- 5	3.5	4
Do.	7	4	2- 3	2.9	3	8	3- 5	3.9	4	8	2- 5	3.8	4
Do.	8	4	1- 1	1.0	1	8	1- 1	1.0	1	8	1- 1	1.0	1
Abdominal segment IV (dorsal)	A	Fairly long, simple.				Fairly long, sometimes branched.				Fairly long, simple.			
Do.	B	16	4- 6	4.5	4	20	6-10	7.7	8	23	6-12	7.6	7
Do.	C	15	3- 4	3.1	3	18	5- 8	6.4	6	24	3- 8	5.3	5
Do.	1	14	1- 1	1.0	1	19	1- 2	1.1	1	22	1- 3	1.9	2
Do.	2	14	2- 4	2.9	3	20	1- 5	2.5	3	22	2- 7	3.9	5
Do.	3	15	2- 6	4.7	5	20	5-10	8.1	8	23	4-11	7.2	6
Do.	4	14	1- 3	2.4	3	19	3- 5	4.2	4	24	2- 4	2.7	3
Do.	5	16	1- 1	1.0	1	20	1- 1	1.0	1	24	1- 1	1.0	1
Abdominal segment IV (ventral)	E	4	1- 1	1.0	1	7	1- 2	1.5	2	7	2- 3	2.4	2
Do.	6	4	2- 3	2.1	2	8	2- 3	2.2	2	8	2- 4	2.6	3
Do.	7	4	2- 3	2.1	2	8	3- 4	3.6	4	8	3- 5	3.7	3
Do.	8	4	1- 1	1.0	1	8	1- 1	1.0	1	8	1- 1	1.0	1
Do.	9	4	1- 1	1.0	1	8	1- 1	1.0	1	8	1- 1	1.0	1
Abdominal segment V (dorsal)	A	Simple.				Usually branched				Branched.			
Do.	B	16	3- 5	4.2	4	20	5- 9	6.8	7	19	6-11	8.7	9
Do.	C	16	2- 3	2.1	2	19	2- 5	3.2	3	24	2- 5	3.4	4
Do.	1	16	1- 1	1.0	1	20	1- 1	1.0	1	24	1- 3	1.8	2
Do.	2	14	1- 4	2.6	3	19	1- 5	3.3	4	24	1- 4	3.1	4
Do.	3	15	2- 4	2.8	3	20	2- 3	2.7	3	24	1- 5	2.8	3
Do.	4	16	1- 4	1.9	2	20	3- 5	3.9	4	24	1- 3	2.4	3
Do.	5	16	1- 1	1.0	1	20	1- 1	1.0	1	24	1- 1	1.0	1
Do.	D	3	3- 3	3.0	3	7	2- 4	2.8	3	8	2- 4	2.9	3
Do.	E	4	1- 2	1.5	2	8	1- 2	1.8	2	8	2- 3	2.1	2
Do.	6	4	1- 2	1.5	2	8	2- 3	2.1	2	8	1- 3	2.4	3
Do.	8	4	1- 1	1.0	1	8	1- 1	1.0	1	8	1- 1	1.0	1
Do.	9	4	1- 1	1.0	1	8	1- 1	1.0	1	8	1- 1	1.0	1
Abdominal segment VI (dorsal)	A	Long, simple.				Long, branched.				Long, branched.			
Do.	B	16	3- 5	4.3	5	19	5- 9	6.8	7	19	5-12	8.6	9
Do.	C	16	1- 2	1.3	1	20	2- 4	2.5	2	21	1- 6	3.4	4
Do.	C'	16	1- 3	2.3	2	20	1- 3	2.0	2	23	1- 3	1.6	2
Do.	1	16	1- 2	1.1	1	19	1- 2	1.1	1	23	1- 2	1.7	2
Do.	2	15	1- 2	1.9	2	20	1- 3	1.7	2	24	1- 3	1.5	1
Do.	4	14	1- 2	1.6	2	20	3- 5	3.7	3	23	1- 3	1.9	1
Do.	5	16	1- 1	1.0	1	20	1- 1	1.0	1	23	1- 1	1.0	1

TABLE 1.—*Pupal characters in the Anopheles leucosphyrus group*—Continued.

	Hairs.	*Anopheles leucosphyrus.*				*Anopheles leucosphyrus* var. *balabacensis.*				*Anopheles* near-*leucosphyrus.*			
		Number examined.	Range of branches.	Average branches.	Commonest branches.	Number evamined.	Range of branches.	Average branches.	Commonest branches.	Number examined.	Range of branches.	Average branches.	Commonest branches.
Abdominal segment VI (ventral)	D	4	1- 1	1.0	1	7	2- 2	2.0	2	8	1- 2	1.8	2
Do.	E	4	1- 2	1.1	1	8	1- 2	1.4	1	8	1- 2	1.9	2
Do.	6	3	1- 2	1.8	2	8	1- 2	1.4	1	7	1- 3	2.0	2
Do.	8	4	1- 1	1.0	1	8	1- 1	1.0	1	8	1- 1	1.0	1
Do.	9	4	1- 1	1.0	1	8	1- 1	1.0	1	8	1- 1	1.0	1
Abdominal segment VII (dorsal)	A	Long, sometimes branched.				Long, branched.				Long, branched.			
Do.	B	15	3- 5	4.0	4	20	5- 8	6.6	8	21	5-12	8.0	9
Do.	C	16	1- 2	1.0	1	19	1- 3	1.8	2	19	1- 3	2.0	2
Do.	1	14	1- 2	1.2	1	17	1- 3	1.9	2	18	1- 3	1.7	2
Do.	2	16	1- 2	1.7	2	20	1- 2	1.6	2	24	1- 2	1.4	1
Do.	3	16	1- 3	2.5	3	19	2- 4	2.8	3	24	1- 3	2.1	3
Do.	4	16	2- 3	2.3	2	19	3- 5	3.9	4	23	1- 3	2.0	2
Do.	5	16	1- 1	1.0	1	20	1- 1	1.0	1	22	1- 1	1.0	1
Abdominal segment VII (ventral)	D	4	1- 1	1.0	1	8	1- 2	1.5	2	8	1- 3	1.9	2
Do.	E	4	1- 3	1.7	1	7	1- 3	2.1	2	8	2- 2	2.0	2
Do.	6	3	2- 2	2.0	2	8	1- 3	2.0	2	8	2- 4	3.0	4
Do.	8	4	1- 2	1.5	1	8	1- 3	1.7	1	8	2- 4	2.6	3
Do.	9	4	1- 1	1.0	1	8	1- 1	1.0	1	8	1- 1	1.0	1
Abdominal segment VIII (dorsal)	A	16	8-13	11.3	11	18	13-17	14.8	14	22	11-19	14.1	13
Do.	A′	16	1- 2	1.9	2	19	1- 2	1.8	2	24	1- 3	2.1	2
Do.	5	16	1- 1	1.0	1	20	1- 1	1.0	1	23	1- 6	1.8	2
Abdominal segment VIII (ventral)	9	4	1- 1	1.0	1	8	1- 1	1.0	1	8	1- 1	1.0	1
Paddle	p	14	1- 2	1.1	1	20	1- 1	1.0	1	22	1- 6	1.8	2
Do.	ap	15	1- 4	2.1	2	20	1- 3	1.7	2	24	1- 3	1.5	1
Do.	Index		1.4 - 1.6				1.3 - 1.5				1.4 - 1.5		

forms are in all planes like a brush. The denticles at the external border of the paddle extend farther down posteriorly, and are coarser in var. *balabacensis* than in near-*leucosphyrus*. *Anopheles leucosphyrus* and var. *balabacensis* are alike in the denticles and in the respiratory trumpets. The paddle hairs and accessory paddle hairs are of no differential value in the group, while the paddle indices (greatest length divided by the greatest width) vary within the same range in all the three forms.

Table 1 shows the variations in the different hairs of the pupæ.

THE ADULTS

Only the characters that have not been treated or have been only slightly discussed by Russell and Baisas [4] will be taken up here.

The buccopharyngeal armature (*Plate 15*).—In pattern the pharyngeal teeth vary among individuals within a species or variety. Those of var. *balabacensis* appear closest to that described and illustrated for *leucosphyrus* of other countries by Sinton and Covell (1927), Barraud and Covell (1928), and Christophers (1933). Var. *balabacensis,* however, has more teeth; the number varies from 10 to 12, whereas those for foreign *leucosphyrus* number only 8. The pharyngeal teeth of the local *leucosphyrus* and near-*leucosphyrus* number 8 each. But the pattern of the individual teeth in either species differs from that of foreign *leucosphyrus*. Moreover, the pattern for Luzon *leucosphyrus* differs from that for *leucosphyrus* found in Mindanao (Plate 15). Those of Luzon are generally more deeply indented by the larger divisions and have the apices somewhat spread; those of Mindanao have smaller divisions and taper toward the apices. The pharyngeal teeth of near-*leucosphyrus* are short and stout and are highly fimbriated at the apices. I do not have many specimens and therefore cannot make enough dissections to find out how constant the peculiarities are.

The wing.—It will be seen from Table 2 that certain indices of the wing veins and cells may be used to differentiate the members of the group. Text fig. 1 shows the parts of the wings used, and the relative lengths of the forked cells of the three species.

[4] The preceding article in this issue.

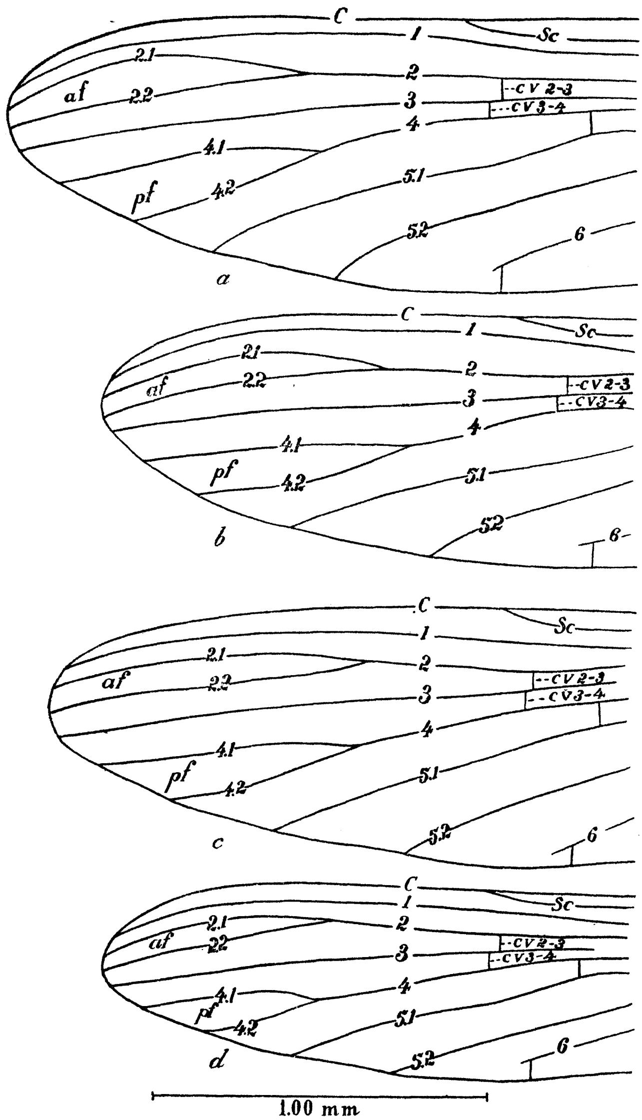

FIG. 1. Apical parts of wings from four species of *Anopheles*, showing relative lengths of forked cells and their respective petioles.

a, *Anopheles leucosphyrus*, from Luzon.

b, *Anopheles leucosphyrus*, from Mindanao.

c, *Anopheles leucosphyrus* var. *balabacensis*.

d, *Anopheles* near-*leucosphyrus*.

Note the positions of the bases of *pf* in relation to those of *af*; *C*, costa; *Sc*, subcosta; 1, 2, 3, 4, and 6, apical parts of longitudinal veins; 2.1 and 2.2, 4.1 and 4.2, and 5.1 and 5.2, forks of veins 2, 4, and 5, respectively; *cv* 2-3, crossvein between veins 2 and 3; *cv* 3-4, crossvein between veins 3 and 4.

TABLE 2.—*Measurements and indices of wing veins and forked cells in the Anopheles leucosphyrus group.*[a]

Species.	Sex.	Vein 2.2.				Petiole of 2.				Vein 4.2.				Petiole of 4.			
		Number examined.	Range of length.	Average length.	Commonest length.	Number examined.	Range of length.	Average length.	Commonest length.	Number examined.	Range of length.	Average length.	Commonest length.	Number examined.	Range of length.	Average length.	Commonest length.
Anopheles leucosphyrus	♂	20	34–43	37.9	38	20	42–63	51.5	51	20	20–30	24.1	23	20	24–30	26.3	26
Do.	♀	37	39–58	46.4	46	37	46–61	54.0	50	37	25–38	31.5	30	37	24–31	27.4	27
Anopheles leucosphyrus var. *balabacensis.*	♂	16	37–50	44.4	44	16	42–60	50.2	50	16	21–31	26.7	25	16	24–32	28.5	28
Do.	♀	16	45–58	51.9	52	16	41–58	50.2	50	16	25–37	30.5	30	16	26–35	29.9	28
Anopheles near-*leucosphyrus.*	♂	8	27–34	30.88	34	8	43–54	49.8	48	8	12–17	14.6	15	8	25–31	28.8	29
Do.	♀	27	34–45	39.0	40	27	46–62	53.8	50	27	16–23	20.1	21	27	28–35	31.3	32

Species.	Sex.	Forked-cell index.				*Af*-petiole index.				*Pf*-petiole index.			
		Number examined.	Range of length.	Average length.	Commonest length.	Number examined.	Range of length.	Average length.	Commonest length.	Number examined.	Range of length.	Average length.	Commonest length.
Anopheles leucosphyrus	♂	20	1.38–1.74	1.57	1.58	20	1.21–1.61	1.36	1.25	20	0 97–1.29	1.09	1.00
Do.	♀	37	1.23–1.96	1.47	1.40	37	0.94–1.37	1.17	1.11	37	0.70–1.07	0.87	0.90
Anopheles leucosphyrus var. *balabacensis.*	♂	16	1.54–1.85	1.77	1.76	16	1.12–1.31	1.25	1.20	16	0.93–1.33	1.07	1.12
Do.	♀	16	1.56–1.88	1.71	1.84	16	0.86–1.07	0.97	0.97	16	0.70–1.18	0 99	0.90
Anopheles near-*leucosphyrus*	♂	8	1.87–2.26	2.11	2.00	8	1.47–1.77	1.61	1.60	8	1.67–2.33	1.97	1.90
Do.	♀	27	1.70–2.13	1.94	1.90	27	1.10–1.70	1.38	1.38	27	1.34–1.88	1.56	1.52

[a] Veins 2.2 and 4.2 are measured from tips to points of bifurcation. Petiole of 2 from point of bifurcation to cv 2–3. Petiole of 4 from point of bifurcation to cv 3–4. Forked-cell index is 2.2 divided by 4.2. Petiole-forked-cell indices are petiole of 2 divided by 2.2 and petiole of 4 divided by 4.2. The measurements given above may be reduced to millimeters by dividing each figure by 60.

TABLE 3.—*Hairs and other characters of pupa of various species of Anopheles.*

	Designation of hairs.	*Anopheles gateri.*				*Anopheles gigas* var. *formosus.*				*Anopheles lindesayi* var. *benguetensis.*				*Anopheles karwari.*			
		Number examined.	Range of branches.	Average branches.	Commonest branches.	Number examined.	Range of branches.	Average branches.	Commonest branches.	Number examined.	Range of branches.	Average branches.	Commonest branches.	Number examined.	Range of branches.	Average branches.	Commonest branches.
Metathorax.	R	16	2- 4	2.9	3	10	2- 4	2.3	2	16	2- 5	3.7	4	20	1- 4	3.0	3
Do.	P	16	4- 6	4.7	5	10	2- 4	3.0	3	16	1- 5	3.7	5	20	1- 3	1.8	2
Do.	O	14	3- 5	3.6	3	10	1- 4	2.2	2	16	1- 3	2.0	2	20	1- 3	1.6	2
Abdominal segment I	H	16	4-11	6.7	7	11	4- 7	4.9	4	15	3- 7	5.5	6	16	1- 1	1.0	1
Do.	K	16	2- 5	3.6	3	11	2- 4	2.9	3	16	1- 2	1.1	1	16	3- 5	4.2	4
Do.	L	16	4- 8	5.6	5	11	4- 5	4.3	4	16	4- 7	5.3	5	14	3- 5	3.7	4
Do.	M	16	2- 5	3.0	3	10	1- 3	1.5	2	15	2- 2	2.0	2	14	2- 5	3.6	4
Do.	S	15	4- 6	5.3	5	11	2- 5	3.6	3	15	2- 4	2.9	3	13	2- 5	3.6	4
Do.	T	16	2- 5	3.2	3	11	2- 3	2.3	2	14	1- 1	1.0	1	15	2- 3	2.7	3
Do.	U	13	1- 1	1.0	1	10	1- 3	2.2	2	16	1- 1	1.0	1	16	1- 1	1.0	1
Abdominal segment II	A	Tiny, blunt				Tiny, blunt				Tiny, blunt				Tiny, blunt.			
Do.	C	16	4-19	7.5	6	12	5- 9	6.7	7	16	2- 8	4.1	3	16	7-11	9.6	11
Do.	1	16	2- 4	2.7	3	12	2- 4	2.9	2	15	1- 1	1.0	1	10	2- 4	2.9	3
Do.	1	16	3- 7	4.5	4	11	2- 5	3.0	2	16	2- 6	3.4	3	10	2- 4	3.2	4
Do.	2	15	2- 4	3.0	3	12	2- 5	4.0	4	16	2- 5	2.8	3	10	2- 5	3.2	3
Do.	2	15	3- 5	3.9	4	12	1- 4	3.0	3	16	3- 7	4.3	3	9	3- 6	4.8	5
Do.	3	16	3- 5	4.3	5	12	1- 2	1.8	2	16	1- 2	1.9	2	12	1- 1	1.0	1
Do.	4	16	9-13	10.7	10	12	6- 8	7.1	8	16	2- 4	3.0	3	10	4- 6	4.9	5
Do.	5	15	1- 3	1.2	1	12	1- 1	1.0	1	13	1- 1	1.0	1	7	1- 2	1.1	1
Abdominal segment III (dorsal)	A	Short, blunt				Short, blunt				Short, blunt				Short, blunt.			
Do.	B	16	10-14	11.1	12	12	7-11	8.5	8	15	5- 9	6.2	6	15	4- 7	5.3	5
Do.	C	16	7-16	12.1	11	12	5- 7	6.2	7	16	5-11	7.4	8	15	3- 8	5.2	5
Do.	1	16	2- 6	3.4	3	12	2- 5	3.4	3	16	1- 2	1.3	1	13	3- 3	3.0	3
Do.	2	14	2- 5	3.2	3	11	2- 4	2.8	3	16	2- 7	4.5	6	10	4- 6	4.6	4
Do.	3	16	5-10	5.8	6	12	1- 2	1.3	1	16	1- 5	2.3	2	9	1- 4	2.0	2
Do.	4	16	9-15	12.5	12	12	5- 6	5.4	5	16	1- 5	2.9	3	9	3- 5	4.1	4
Do.	5	15	1- 2	1.2	1	10	1- 3	1.3	1	16	1- 1	1.0	1	9	1- 1	1.0	1

Abdominal segment III (ventral)	E	12	1- 4	3.1	3	8	2- 3	2.1	2	12	2- 3	2.4	2				
Do.	6	12	3- 4	3.7	4	8	3- 4	3.0	3	12	2- 4	2.6	3				
Do.	7	12	3- 4	3.3	3	8	3- 6	3.9	3	12	2- 5	3.5	4				
Do.	8	12	2- 4	3.5	4	8	1- 2	1.0	1	12	1- 1	1.0	1				
Do.	9					8	1- 1	1.0	1								
Abdominal segment IV (dorsal)	A	Short blunt				Pointed				Pointed				Tiny, blunt.			
Do.	B	16	5-13	9.0	12	10	7-10	7.8	7	16	5-12	8.3	8	18	3- 5	3.3	3
Do.	C	16	5-11	9.4	10	11	5- 6	5.2	5	16	2-12	6.6	6	16	2- 5	3.0	3
Do.	1	16	1- 3	2.1	2	12	2- 3	2.3	2	16	1- 1	1.0	1	17	1- 2	1.1	1
Do.	2	16	2- 4	2.9	3	12	2- 3	2.6	2	16	2- 6	3.9	3	17	2- 5	3.9	4
Do.	3	16	6-11	7.4	8	12	3- 5	4.1	4	16	1- 7	3.4	4	16	3- 5	4.1	4
Do.	4	16	11-14	11.5	11	12	2- 4	3.0	3	15	1- 3	2.1	2	17	1- 2	1.3	1
Do.	5	7	1- 1	1.0	1	12	1- 3	1.6	1	16	1- 1	1.0	1	17	1- 2	1.1	1
Abdominal segment IV (ventral)	E	12	2- 4	2.3	2	8	1- 2	1.3	1	12	1- 1	1.0	1				
Do.	6	12	2- 5	3.3	3	8	2- 3	2.8	3	12	2- 4	2.9	3				
Do.	7	12	2- 4	2.8	3	8	1- 4	3.4	4	11	2- 6	3.7	4				
Do.	8	12	2- 4	2.8	3	8	1- 1	1.0	1	12	1- 1	1.0	1				
Do.	9					8	1- 1	1.0	1	12	1- 1	1.0	1				
Abdominal segment V (dorsal)	A	Short blunt				Pointed				Long, pointed				Long, pointed.			
Do.	B	16	4- 8	6.1	6	12	5- 7	6.0	6	16	11-18	13.1	12	16	1- 3	1.7	2
Do.	C	16	2- 4	2.8	3	12	2- 4	3.5	4	16	2- 8	4.9	5	14	1- 1	1.0	1
Do.	1	15	1- 2	1.6	2	11	1- 2	1.9	2	16	1- 1	1.0	1	18	1- 3	1.3	1
Do.	2	16	2- 4	2.9	3	12	2- 3	2.6	3	16	2- 4	3.1	3	17	1- 3	2.2	2
Do.	3	16	2- 4	2.9	3	12	1- 2	1.5	2	16	1- 4	2.2	2	17	1- 3	2.1	2
Do.	4	15	10-16	11.8	11	12	2- 4	3.1	3	16	1- 2	1.4	1	17	1- 2	1.2	1
Do.	5	7	1- 1	1.0	1	12	1- 3	1.3	1	14	1- 1	1.0	1	16	1- 1	1.0	1
Abdominal segment V (ventral)	D	12	2- 3	2.6	3	8	2- 3	2.9	3	12	2- 3	2.5	3				
Do.	E	12	2- 3	2.3	2	8	1- 1	1.0	1	12	1- 2	1.2	1				
Do.	6	12	3- 5	3.4	3	8	2- 3	2.5	3	12	2- 4	3.0	3				
Do.	8	12	1- 3	1.6	1	8	1- 2	1.0	1	12	1- 1	1.0	1				
Do.	9	12	1- 1	1.0	1	8	1- 2	1.1	1	12	1- 1	1.0	1				

TABLE 3.—*Hairs and other characters of pupa of various species of Anopheles*—Continued.

	Designation of hairs.	*Anopheles gateri.*				*Anopheles gigas* var. *formosus.*				*Anopheles lindesayi* var. *benguetensis.*				*Anopheles karwari.*			
		Number examined.	Range of branches.	Average branches.	Commonest branches.	Number examined.	Range of branches.	Average branches.	Commonest branches.	Number examined.	Range of branches.	Average branches.	Commonest branches.	Number examined.	Range of branches.	Average branches.	Commonest branches.
Abdominal segment VI (dorsal)	A	Short, blunt				Long, pointed				Long, pointed				Long, pointed.			
Do	B	16	3–6	4.8	5	12	4–11	6.3	6	16	8–19	12.8	12	16	1–2	1.3	1
Do	C	16	1–3	2.3	2	12	2–4	2.5	2	16	2–5	3.3	2	17	1–1	1.0	1
Do	C′	16	1–2	1.4	1	12	1–2	1.0	1	16	1–3	2.3	3	17	1–3	2.0	2
Do	1	16	1–2	1.5	1	12	1–2	1.2	1	16	1–1	1.0	1	18	1–3	1.4	1
Do	2	16	1–3	2.0	2	12	1–1	1.0	1	16	1–2	1.7	2	17	1–2	1.3	1
Do	4	14	6–12	9.3	9	12	3–4	3.1	3	16	1–2	1.0	1	17	1–2	1.1	1
Do	5	11	1–1	1.0	1	12	1–2	1.0	1	16	1–1	1.0	1	14	1–1	1.0	1
Abdominal segment VI (ventral	D	12	1–2	1.4	1	8	1–2	1.0	1	12	1–2	1.2	1				
Do	E	10	2–4	3.1	3	8	1–2	1.2	1	12	1–3	2.1	2				
Do	6	12	2–5	3.3	3	8	1–3	1.9	2	12	2–4	3.2	3				
Do	8	12	1–2	1.2	1	8	1–1	1.0	1	12	1–2	1.0	1				
Do	9	12	1–1	1.0	1	8	1–1	1.0	1	12	1–2	1.1	1				
Abdominal segment VII (dorsal)	A	Stout, blunt				Long, pointed				Very long, pointed				Long, pointed.			
Do	B	16	3–7	4.8	5	12	4–8	6.6	8	15	9–16	11.1	11	18	1–2	1.3	1
Do	C	16	1–2	1.3	1	12	1–3	1.8	2	16	1–8	3.1	2	20	1–2	1.1	1
Do	1	16	2–6	4.0	4	12	3–4	2.8	3	16	1–2	1.6	2	20	1–3	1.1	1
Do	2	16	2–3	2.2	2	12	1–1	1.0	1	16	1–3	2.0	2	19	1–2	1.3	1
Do	3	15	4–7	5.0	5	12	1–3	1.7	2	16	1–3	3.3	3	20	1–3	1.9	2
Do	4	16	4–11	6.3	6	12	2–4	2.9	3	16	1–2	1.9	2	20	1–2	1.4	1
Do	5	16	1–3	1.1	1	12	1–1	1.0	1	12	1–1	1.0	1	17	1–1	1.0	1
Abdominal segment VII (ventral)	D	12	1–3	1.8	2	8	1–2	1.0	1	12	1–2	1.3	1				
Do	E	12	2–5	3.6	4	8	1–3	1.5	2	12	1–3	1.8	2				
Do	6	12	5–10	7.3	7	8	1–3	1.5	1	12	2–3	2.9	3				
Do	8	12	2–4	2.3	2	8	1–2	1.2	1	12	1–3	1.8	2				
Do	9	12	1–1	1.0	1	8	1–1	1.0	1	12	1–1	1.0	1				

Abdominal segment VIII (dorsal).	A	9	12–20	15.9	15	11	9–17	12.9	11	16	13–20	16.4	17	20	7–16	10.7	12
Do.	A′	16	3– 4	3.0	3	12	1– 2	1.0	1	16	1– 2	1.7	2	18	1– 3	1.4	1
Do.	5	13	1– 1	1.0	1	12	1– 1	1.0	1	16	1– 1	1.0	1	19	1– 1	1.0	1
Abdominal segment VII (ventral)	9	16	1– 1	1.0	1	12	1– 1	1.0	1	16	1– 1	1.0	1				
Paddle	p	15	5–12	8.3	8	12	1– 1	1.0	1	Simple, long, hooked.				Simple, long, hooked.			
Do.	ap	16	3– 6	4.1	4	Short, simple.				16	2– 2	2.0	2	20	1– 3	2.1	2
Denticles		Fairly coarse				Fine				None.				Rudimentary.			
Hairs		Cover posterior half				Short, tiny				Long, numerous, cover posterior two-thirds.				Fairly long.			
Index		1.25–1.30				1.35–1.40				1.80–1.90				1.45–1.55			

SUMMARY AND CONCLUSIONS

1. Additional characters that will help in the differential diagnosis of the members of the *Anopheles leucosphyrus* group are presented.

2. *Anopheles* near-*leucosphyrus* is considered to be a distinct species, and should, therefore, be given a definite name. I leave this to Dr. W. V. King, who has the first specimens of this species.

3. The form found in Palawan and Balabac is assigned to varietal rank, for which the name *A. leucosphyrus* var. *balabacensis* is proposed.

4. The form found in Luzon and Mindanao, despite minor differences, is considered identical with *A. leucosphyrus* Dönitz (1901).

OTHER SPECIES

ANOPHELES GATERI sp. nov.

Type specimens.—Male (lot R65–38) and female (lot R65–6) and their corresponding larval skins, together with some cotypes, are in the collections of the Bureau of Health, Manila.

Type locality.—Iwahig, Palawan.

Collector.—Mr. Andres Nono.

Date of collection.—June, 1934.

This species was given the provisional designation of *A. baezai* var. (?) in the papers of Russell and Baisas (1934–1936). The definite name, *A. gateri,* which I propose, is necessary for the convenience of Philippine workers.

Originally found in the larval stage by Dr. C. Manalang, in Zamboanga, Mindanao, *A. gateri* has subsequently been reported from various places in the Philippines. It was found in northern Mindanao by Mr. D. Santiago; in a number of the Visayan Islands by Dr. P. F. Russell and Mr. Andres Nono; in Culion and Iwahig by Mr. A. Nono; and in Balabac Island by Mr. F. Guinto. The northern limit of its distribution seems to be Camarines Norte, Luzon, where it was encountered by Dr. E. Celis, of the Bureau of Health, in 1933, and subsequently, 1934, by Mr. D. Santiago. It has not been met with farther north. It seems to be widely distributed southward and east and west in the Archipelago.

The first adult secured of this species was a male, which emerged from one of the larvæ collected in the small island of Cagayan between Palawan and Negros, by Dr. P. F. Russell

and Mr. Andres Nono. This specimen is also in the Bureau of Health collection.

The larva.—A description of the larva is given in the practical illustrated key to larvæ of Philippine anopheles mentioned above.

The pupa.—The characters of the pupa are presented in Table 3. Plates 3 and 4 show the principal parts. Note the respiratory trumpet.

The adult.—Imaginal characters are given by Russell and Baisas in the article preceding this one. The buccopharyngeal armature carries no teeth.

In Table 3 are also included the pupal characters of *Anopheles gigas* var. *formosus*, *A. lindesayi* var. *benguetensis*, and *A. karwari*.[5] Some of the plates illustrate parts of these species. The illustrations and descriptions may be compared with those given by Senevet (1930, 1931, and 1932).

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[5] Pupal mounts of *karwari* have been lent me by Mr. Domingo Santiago to whom I am much indebted in many ways.

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ILLUSTRATIONS

[All the illustrations were drawn with the aid of a camera lucida. The respiratory trumpets were drawn without cover glass; the other parts were drawn from flat preparations. The following designations of hairs and other characters apply to all the plates of the same parts.]

PLATE 1. ANOPHELES GIGAS VAR. FORMOSUS LUDLOW

Left half, dorsal side, of some pupal segments, showing—

Metathorax. Hairs *R*, *P*, and *O*.

Abdominal segment I. Hairs *H*, *K*, *L*, *M*, *S*, *T*, and *U*; *t* is the base of the dendritic tuft.

Abdominal segment II. *A*, Spine; *C*, large dorsal hair in most species, but not so large in *formosus;* 1-1, 2-2, 3, 4, and 5, other dorsal hairs.

Abdominal segment III. *A*, Spine; *B*, and *C*, large dorsal hairs; 1, 2, 3, 4, and 5, other dorsal hairs.

Abdominal segment VI. *A*, Spine; *B*, *C*, and *C'*, large dorsal hairs; 1, 2, 4, and 5, other dorsal hairs.

PLATE 2. ANOPHELES GIGAS VAR. FORMOSUS LUDLOW

FIG. 1. Respiratory trumpet, top view.
2. Respiratory trumpet, side view.
3. Paddle, showing *e*, external border of paddle with denticles and hairs; *p*, paddle hair; *ap*, accessory paddle hair. Part of segment VIII is also shown, *A*, spine; *A'*, accessory hair of spine; 5, dorsal hair.

PLATE 3. ANOPHELES GATERI SP. NOV.

PLATE 4. ANOPHELES GATERI SP. NOV.

FIG. 1. Respiratory trumpet.
2. Paddle and part of segment VIII.

PLATE 5. ANOPHELES LINDESAYI VAR. BENGUETENSIS KING

PLATE 6. ANOPHELES LINDESAYI VAR. BENGUETENSIS KING

FIG. 1. Respiratory trumpet.
2. Paddle and part of segment VIII.

PLATE 7. ANOPHELES KARWARI JAMES

PLATE 8. ANOPHELES KARWARI JAMES

FIG. 1. Respiratory trumpet.
2. Paddle and part of segment VIII.

PLATE 9. ANOPHELES LEUCOSPHYRUS DÖNITZ

PLATE 10. ANOPHELES LEUCOSPHYRUS DÖNITZ

FIG. 1. Respiratory trumpet.
2. Paddle and part of segment VIII.

PLATE 11. ANOPHELES LEUCOSPHYRUS VAR. BALABACENSIS VAR. NOV.

PLATE 12. ANOPHELES LEUCOSPHYRUS VAR. BALABACENSIS VAR. NOV.

FIG. 1. Respiratory trumpet.
2. Paddle and part of segment VIII.

PLATE 13. ANOPHELES NEAR-LEUCOSPHYRUS KING

PLATE 14. ANOPHELES NEAR-LEUCOSPHYRUS KING

FIG. 1. Respiratory trumpet.
2. Paddle and part of segment VIII.

PLATE 15. BUCCOPHARYNGEAL TEETH

FIG. 1. *Anopheles leucosphyrus,* from Luzon; teeth 3 to 8.
2. *Anopheles leucosphyrus* var. *balabacensis* var. nov., teeth 6 to 12.
3. *Anopheles* near-*leucosphyrus,* teeth 4 to 8.
4. *Anopheles leucosphyrus* var. *balabacensis* var. nov., teeth, whole set.
5. *Anopheles leucosphyrus,* from Mindanao; teeth 4 to 8.
6. *Anopheles* near-*leucosphyrus,* teeth 5 to 8.

TEXT FIGURE

FIG. 1. Apical parts of wings from three species of *Anopheles,* showing relative lengths of forked cells and their respective petioles.
a, Anopheles leucosphyrus, from Luzon.
b, Anopheles leucosphyrus, from Mindanao.
c, Anopheles leucosphyrus var. *balabacensis.*
d, Anopheles near-*leucosphyrus.*
Note the positions of the bases of *pf* in relation to those of *af; C,* costa; *Sc,* subcosta; 1, 2, 3, 4, and 6, apical parts of longitudinal veins; 2.1 and 2.2, 4.1 and 4.2, and 5.1 and 5.2, forks of veins 2, 4, and 5, respectively; *cv* 2-3, crossvein between veins 2 and 3; *cv* 3-4, crossvein between veins 3 and 4.

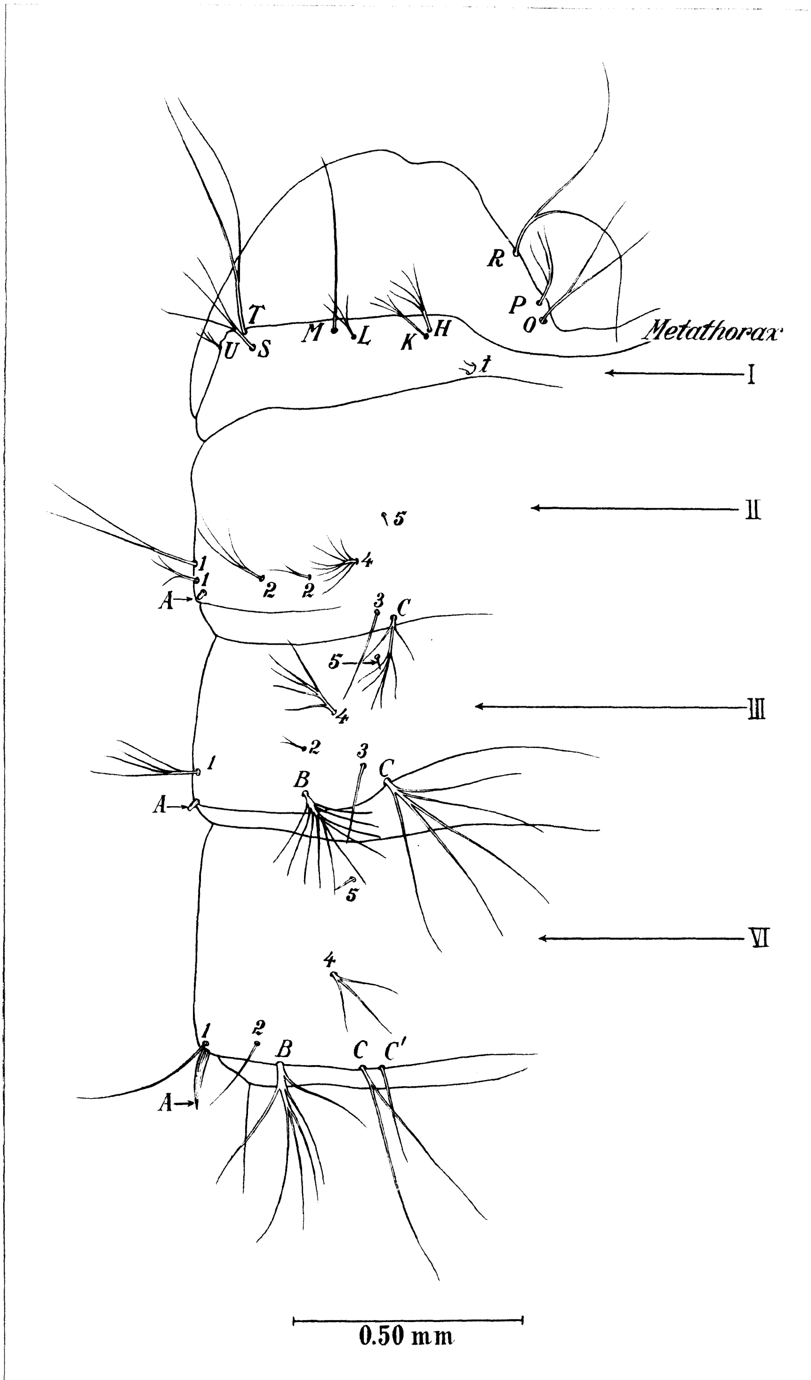

PLATE 1. ANOPHELES GIGAS VAR. FORMOSUS.

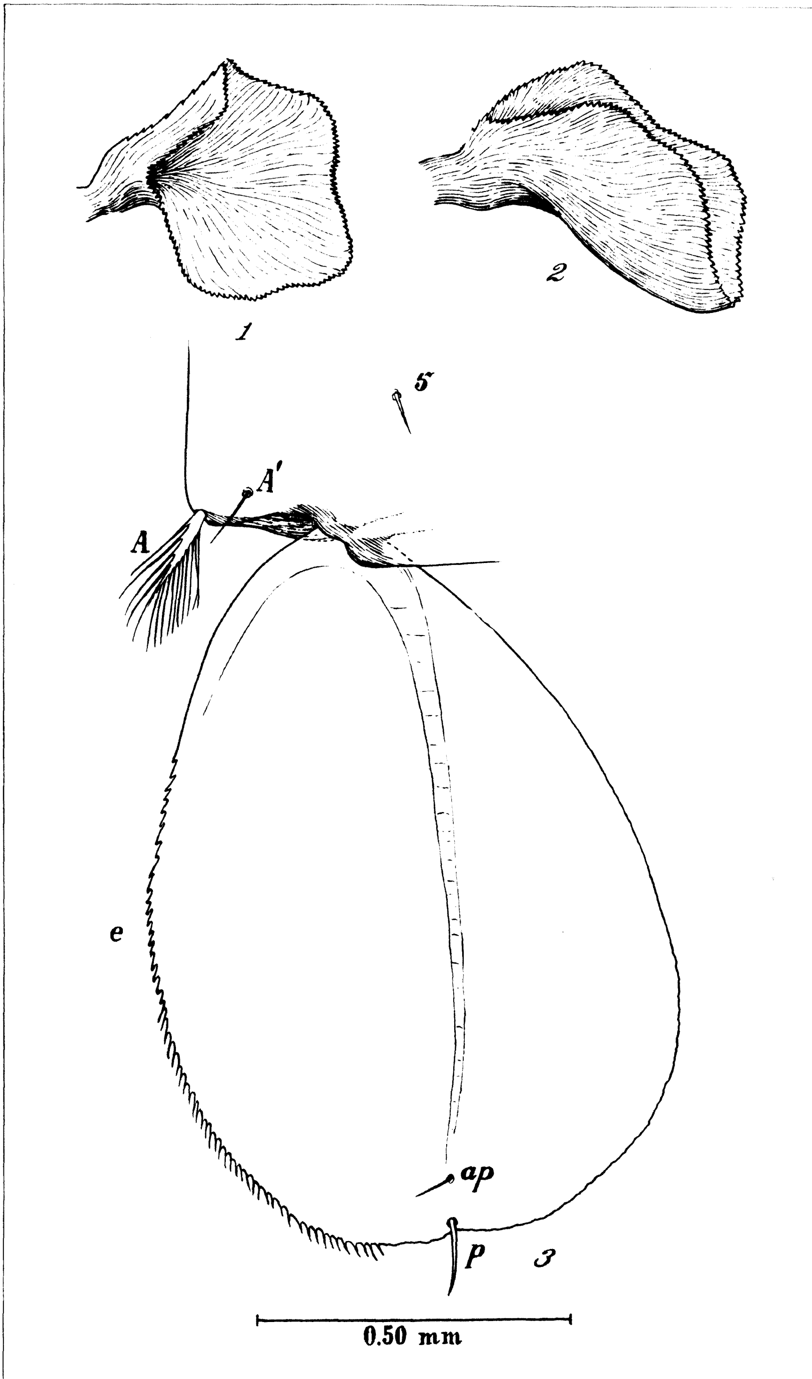

PLATE 2. ANOPHELES GIGAS VAR. FORMOSUS.

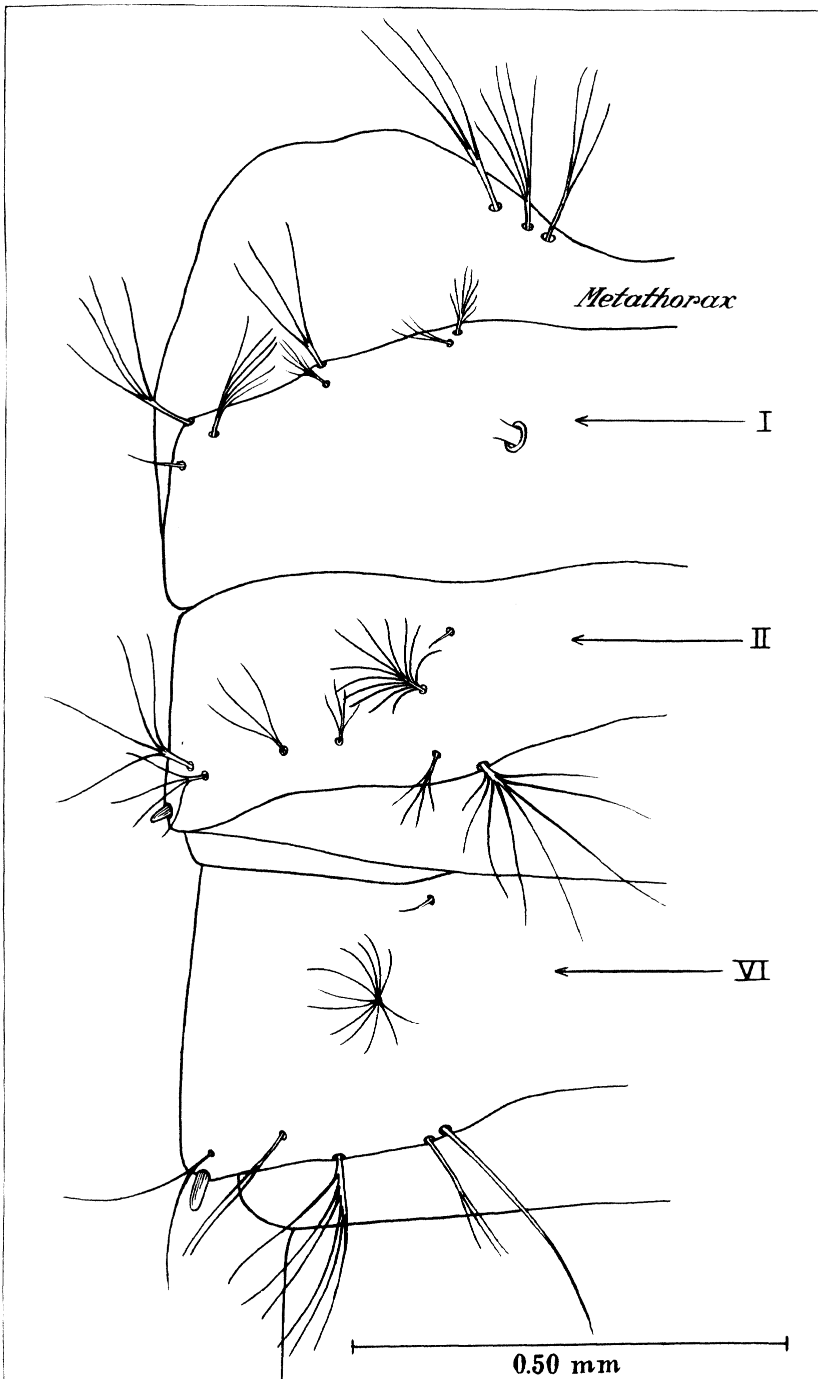

PLATE 3. ANOPHELES GATERI.

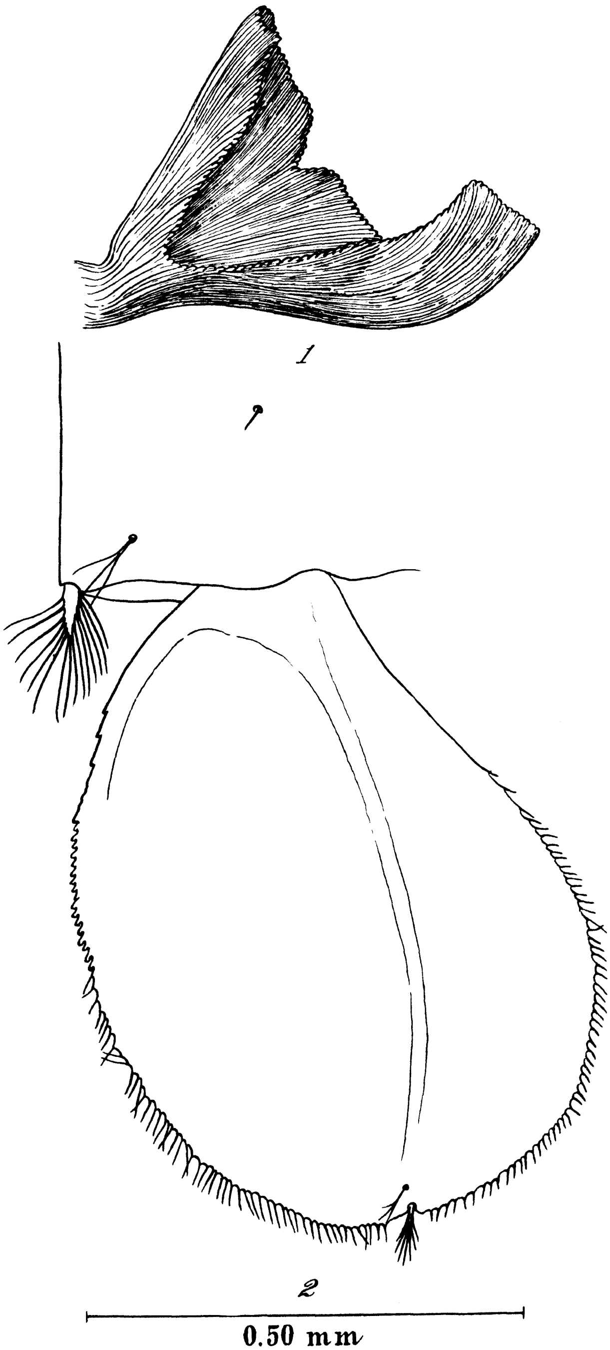

PLATE 4. ANOPHELES GATERI.

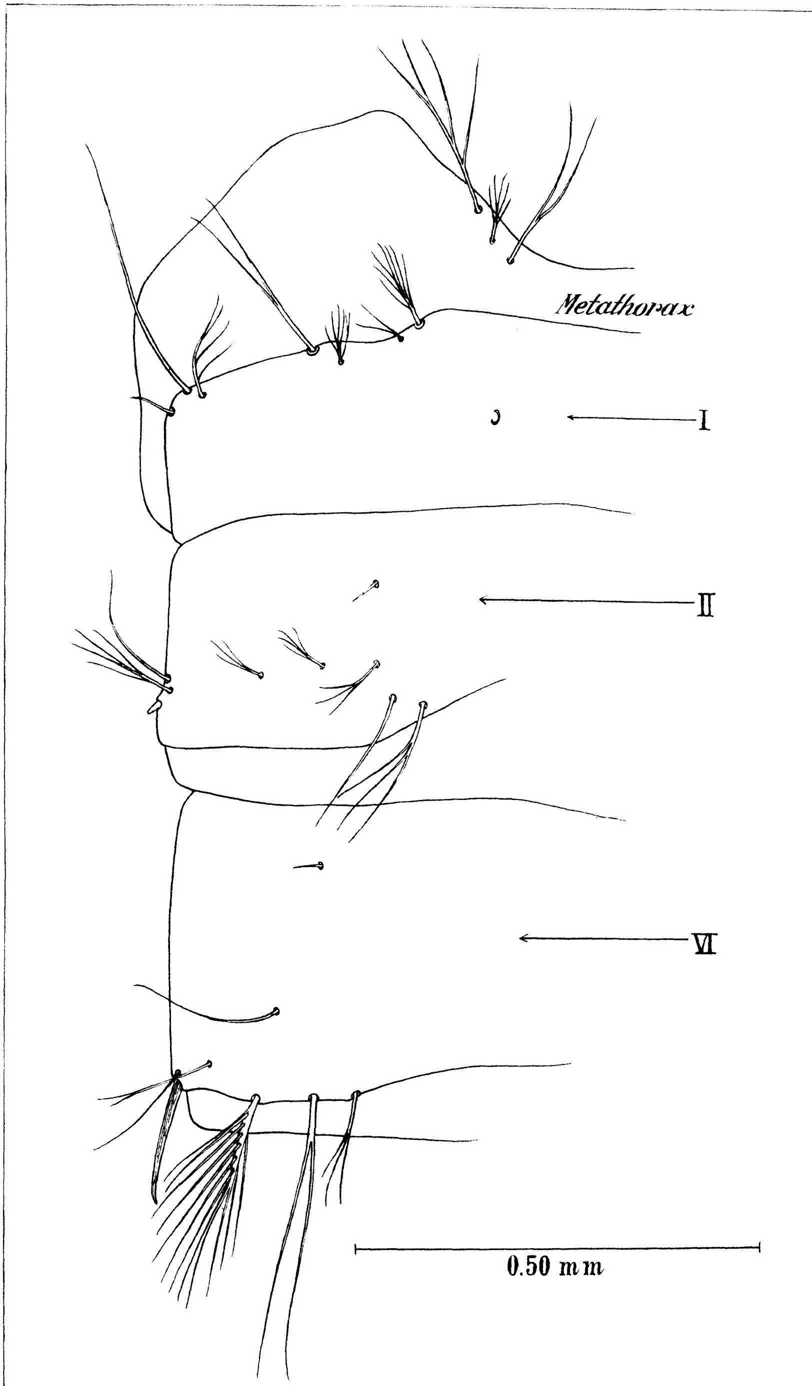

PLATE 5. ANOPHELES LINDESAYI VAR. BENGUETENSIS.

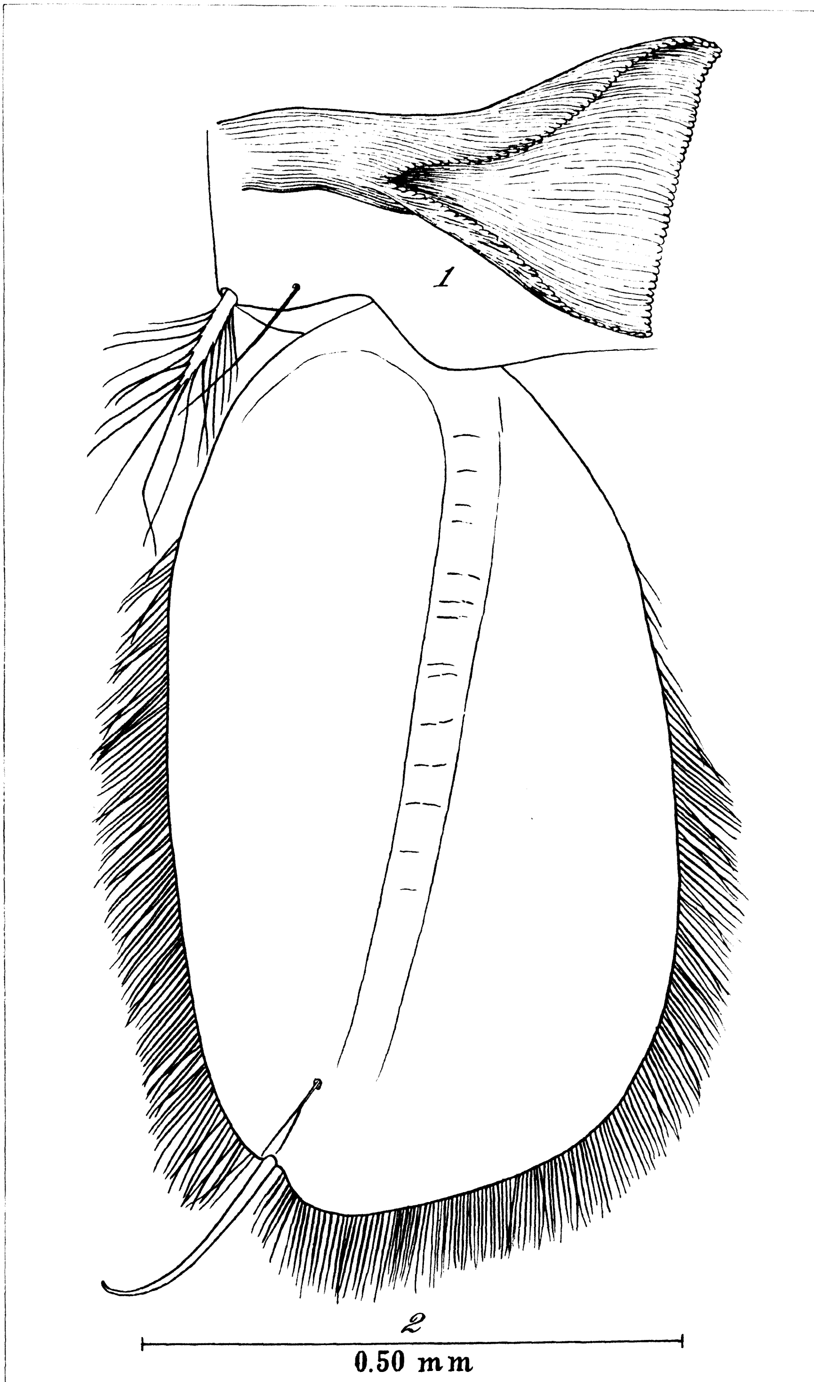

PLATE 6. ANOPHELES LINDESAYI VAR. BENGUETENSIS.

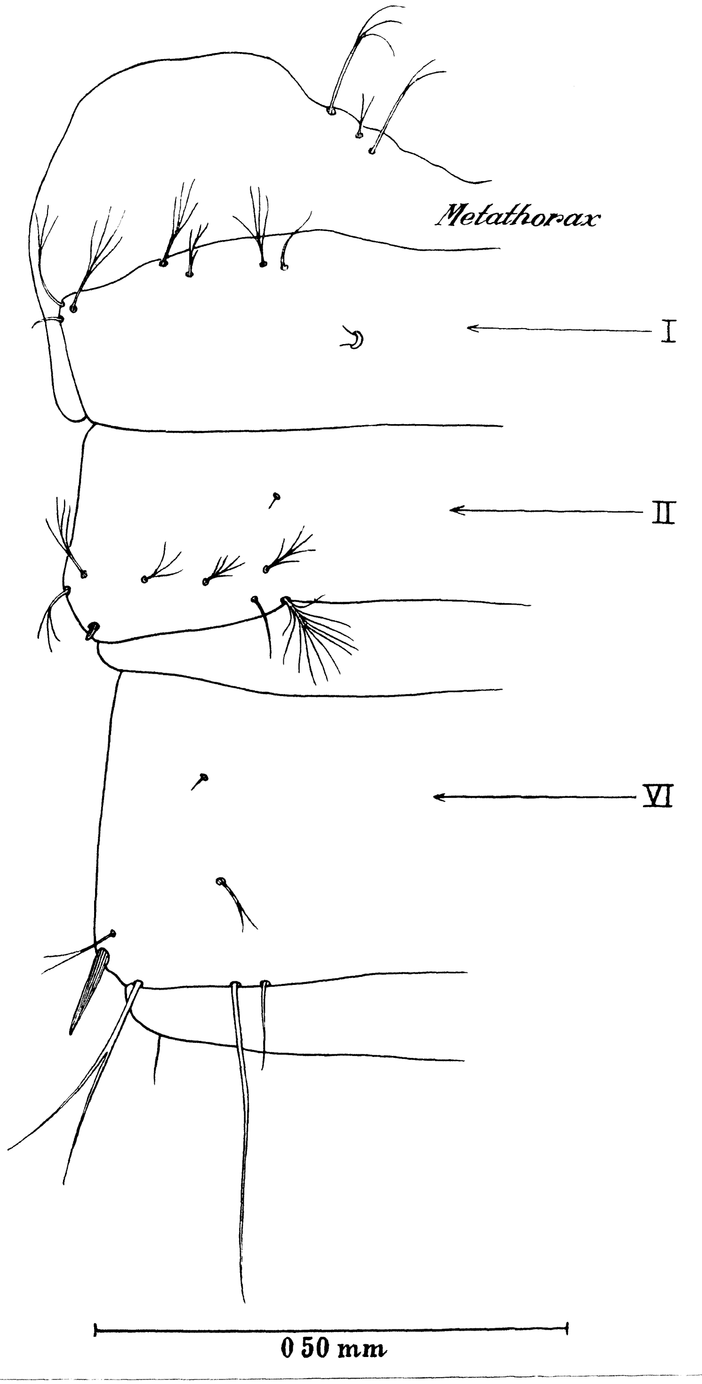

PLATE 7. ANOPHELES KARWARI.

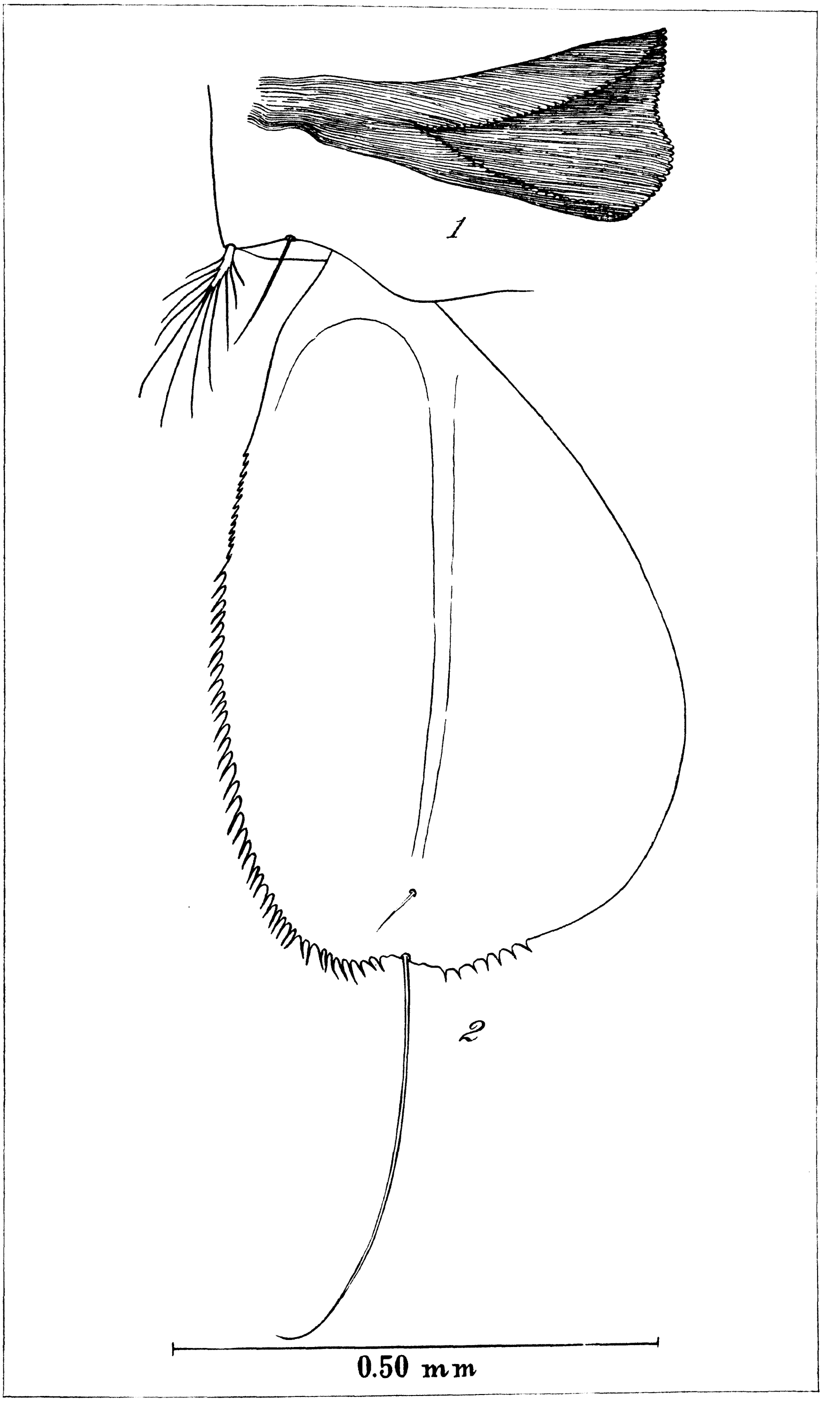

PLATE 8. ANOPHELES KARWARI.

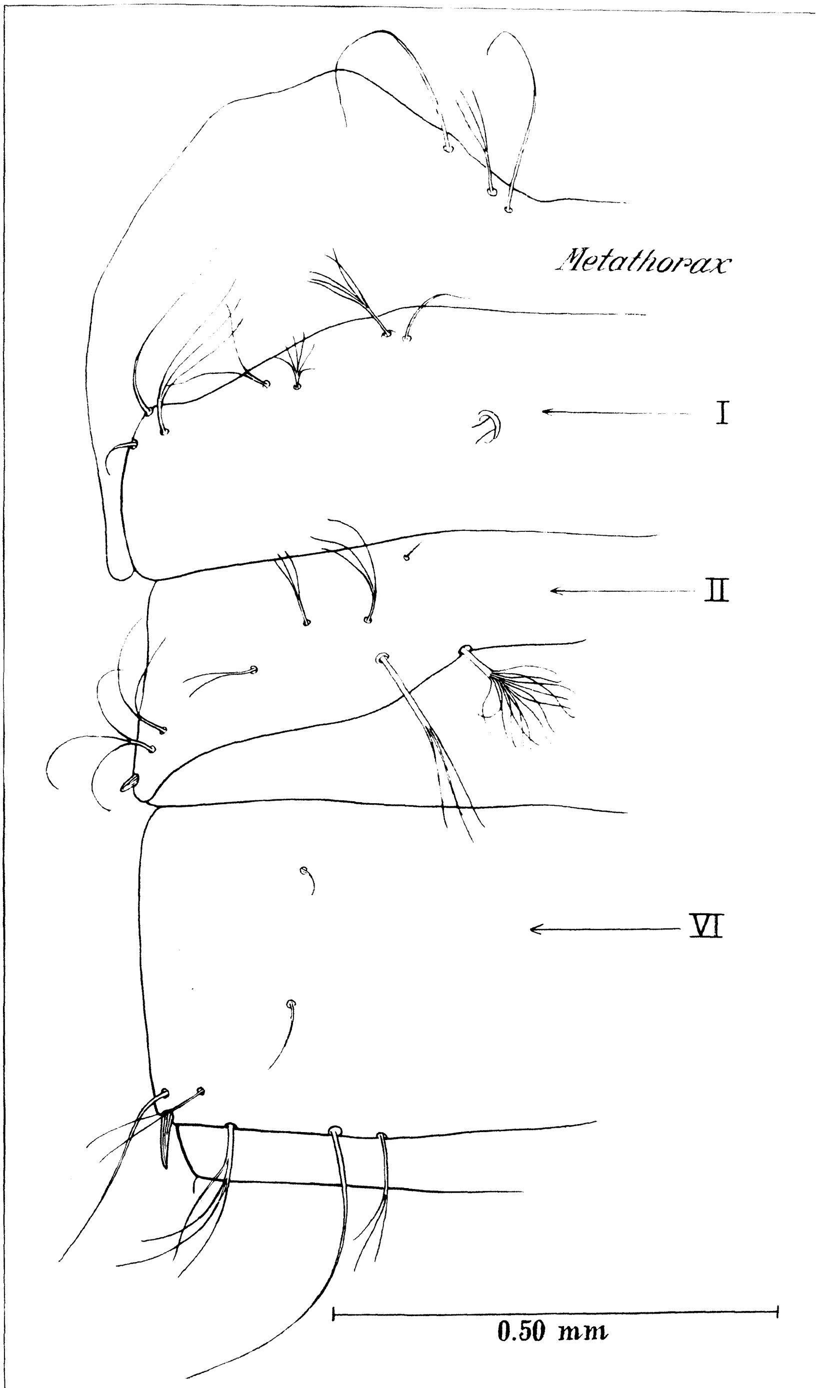

PLATE 9. ANOPHELES LEUCOSPHYRUS.

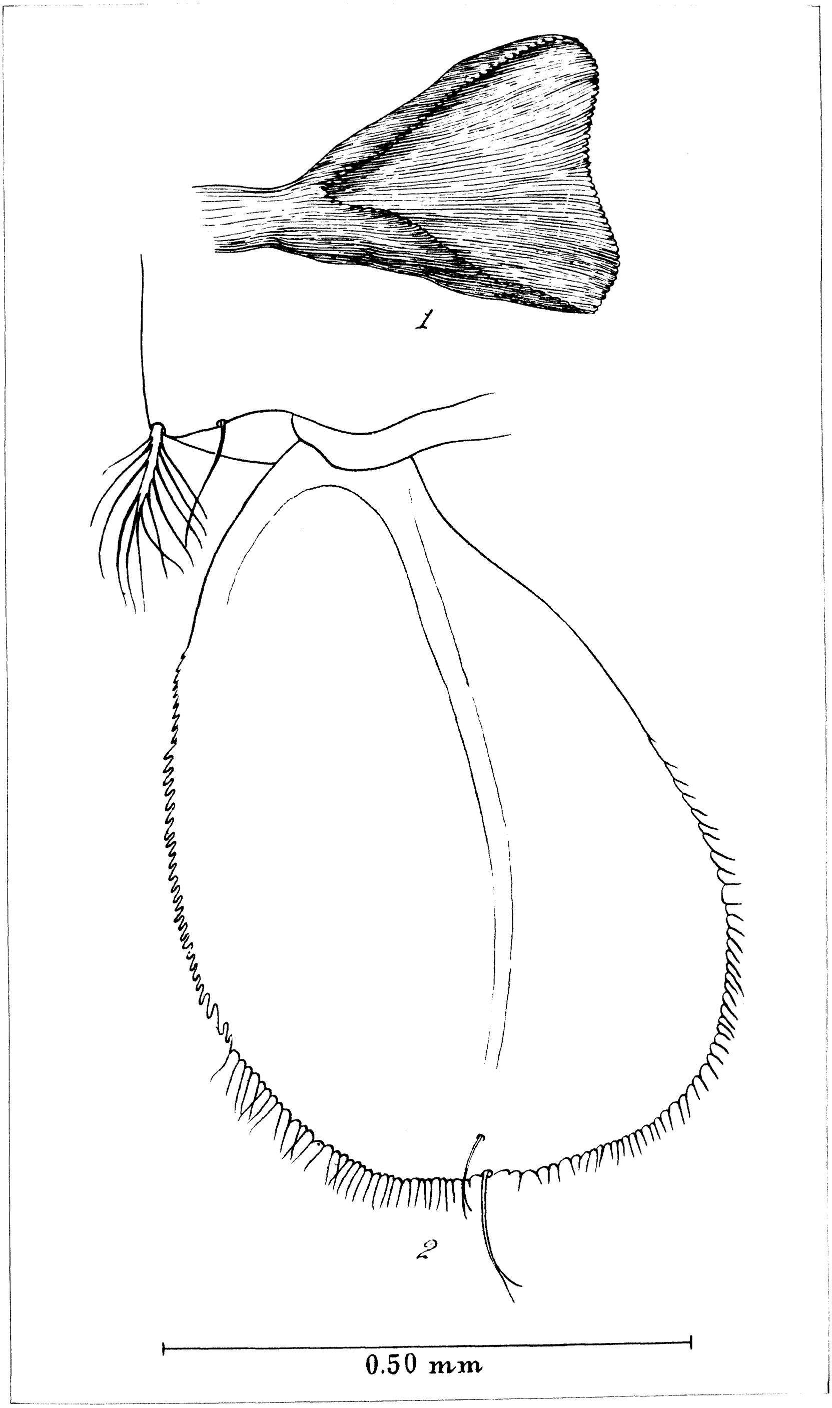

PLATE 10. ANOPHELES LEUCOSPHYRUS.

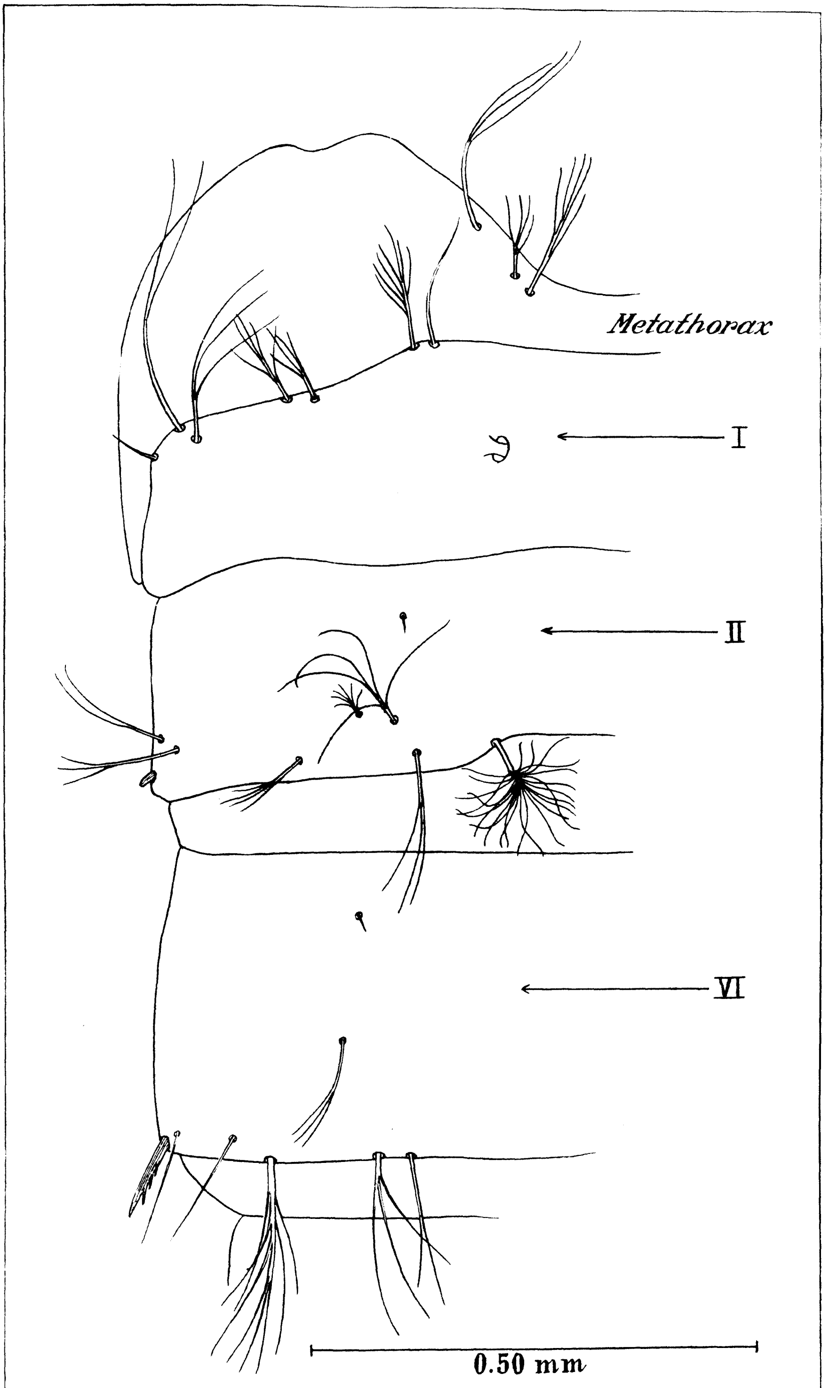

PLATE 11. ANOPHELES LEUCOSPHYRUS VAR. BALABACENSIS.

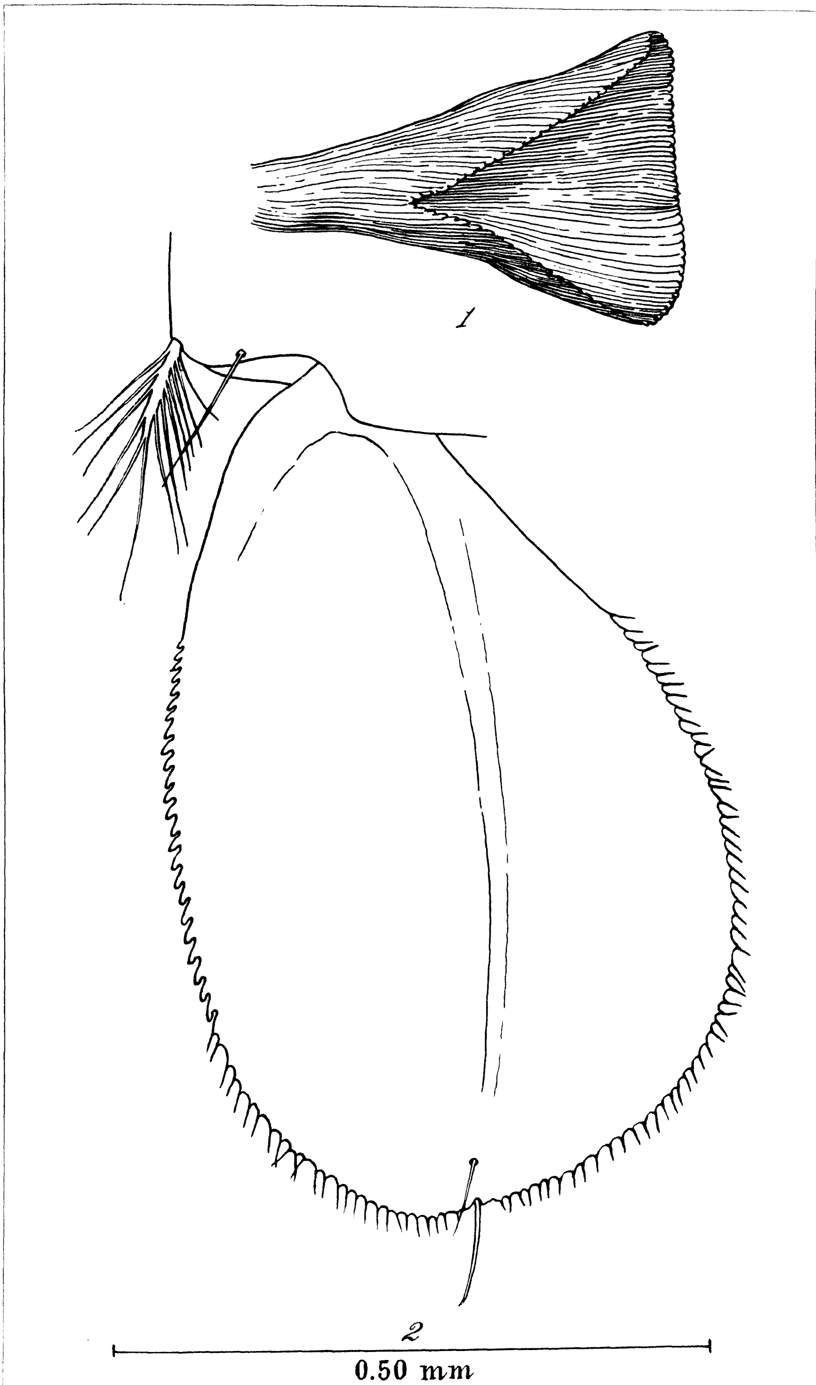

PLATE 12. ANOPHELES LEUCOSPHYRUS VAR. BALABACENSIS.

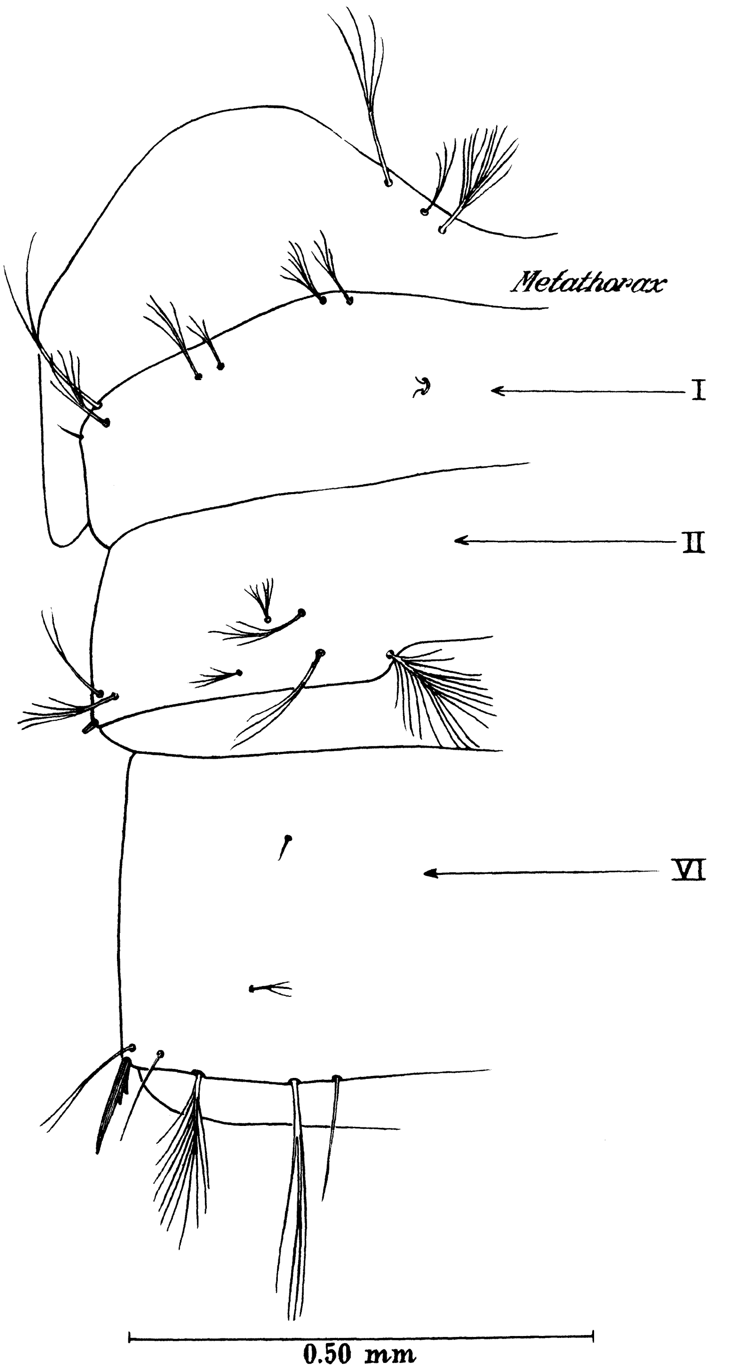

PLATE 13. ANOPHELES NEAR-LEUCOSPHYRUS.

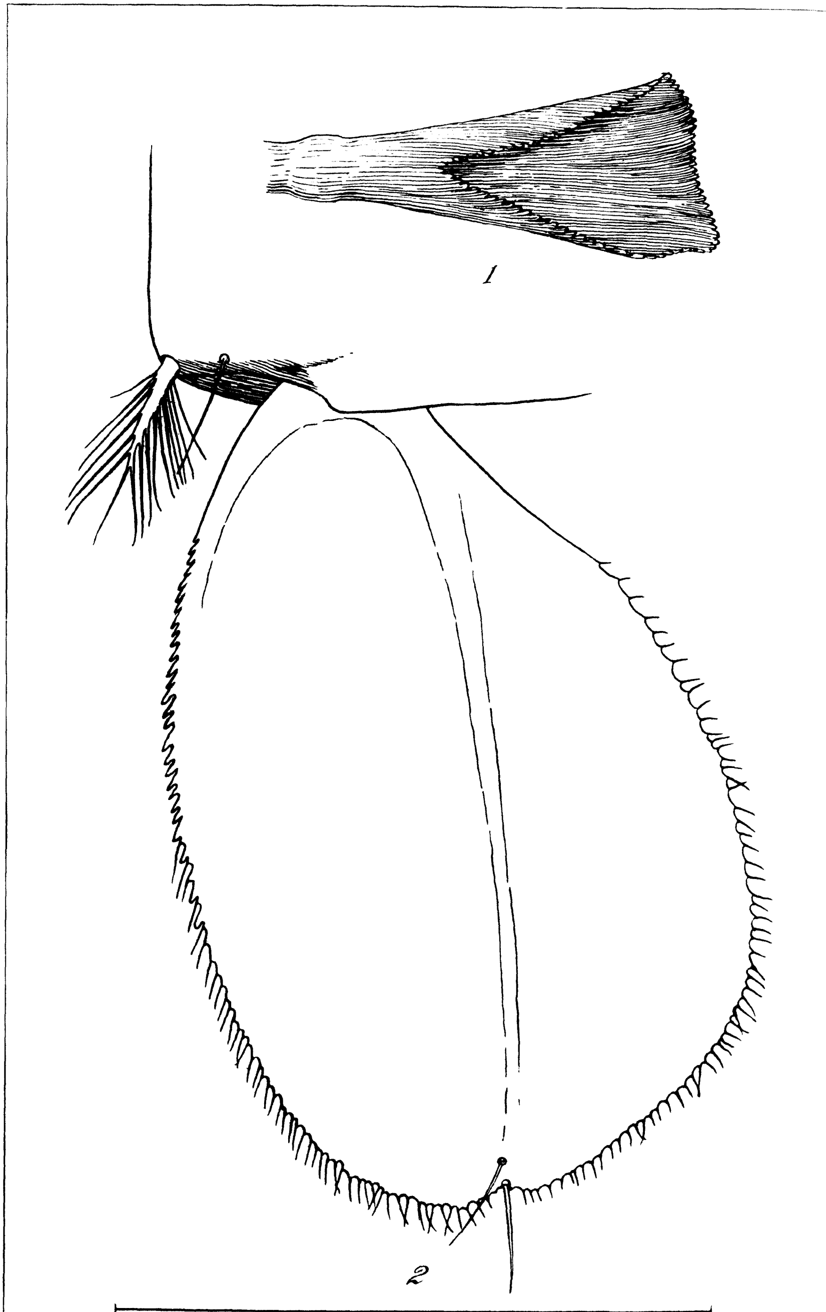

PLATE 14. ANOPHELES NEAR-LEUCOSPHYRUS

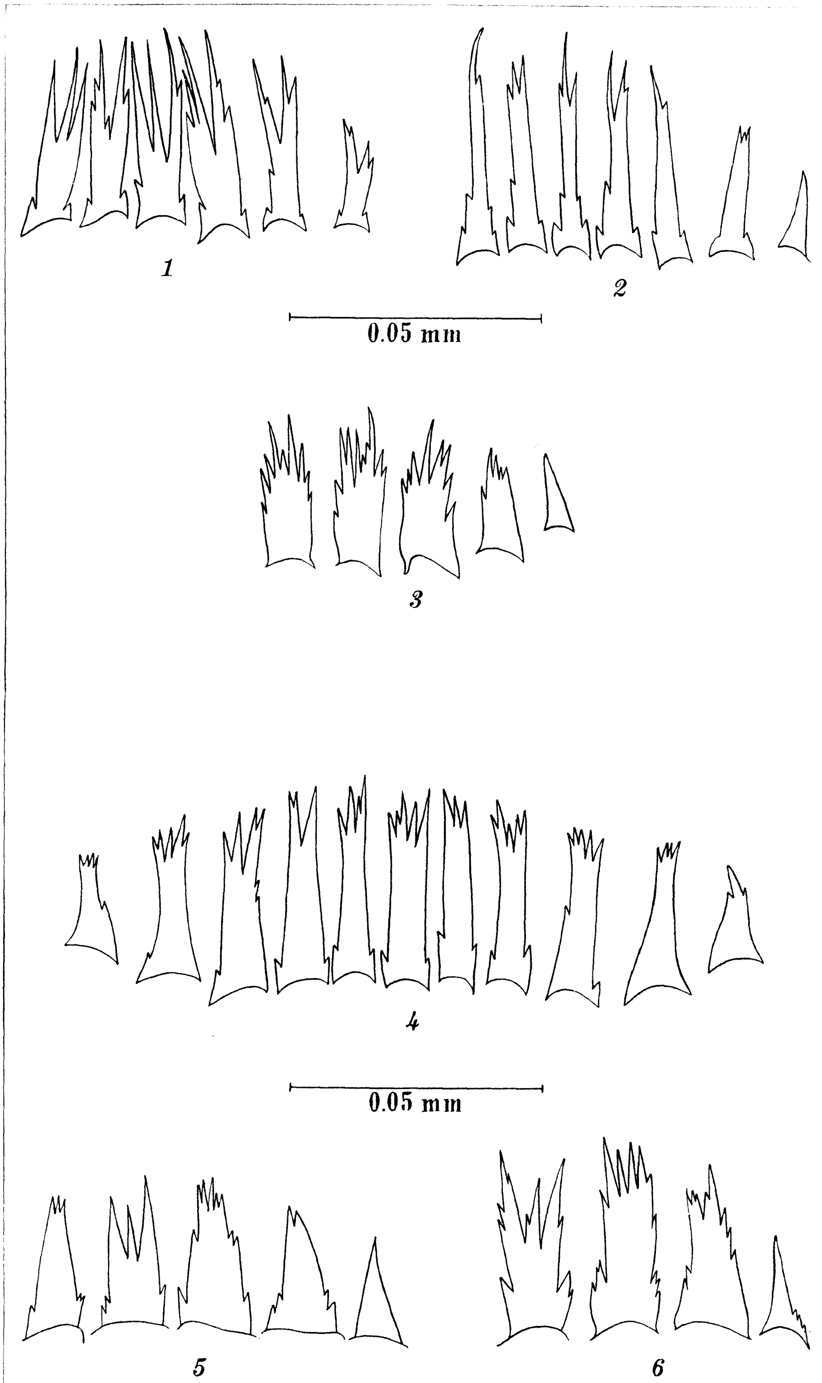

PLATE 15.

THE AMERICAN SPECIES OF PSYCHODA (DIPTERA: PSYCHODIDÆ)[1]

By F. DEL ROSARIO

Of the National Museum Division, Bureau of Science, Manila

SIX PLATES AND ONE TEXT FIGURE

INTRODUCTION

The family Psychodidæ has recently been the subject of great attention, especially the members of the blood-sucking genus *Phlebotomus*, but hitherto comparatively little has been published on the nonblood-sucking forms of the genus *Psychoda* Latreille.

Psychoda includes the flies popularly known as "moth flies" because of the peculiar rooflike position of the wings when the adults are at rest, which gives them the appearance of tiny moths. This group of insects (also known as "owl midges") includes the commonest species of flies that breed in the bacterial film of the sprinkling filter beds used for the purification of sewage. These flies are usually found about water-logged ditches, along creeks filled with decaying vegetable and organic matter, along small streams where water trickles, near piles of decaying leaves, and in similar places.

Some reference has already been made to the medical importance of several species. Headlee and Beckwith (1918) have called attention to two species, *Psychoda alternata* Say and *Ps. phalænoides* Linnæus, which breed in such numbers in sprinkling filter beds as to be a nuisance in human habitations around or near the plant by entering the buildings and getting into food. The persons concerned believe that these flies are the carriers of infections from which the inhabitants suffer. The

[1] Thesis presented to the faculty of the School of Hygiene and Public Health of the Johns Hopkins University, Baltimore, in partial fulfillment of the requirements for the degree of Doctor of Science in Hygiene (Medical Entomology), October, 1934. The writer was a fellow of the International Health Division of the Rockefeller Foundation from September 15, 1932, to October 15, 1934; it is a pleasure to acknowledge his indebtedness to this institution. Read before the Third Philippine Science Convention, held in Manila, February 28, 1935.

same authors stated that the flies, emerging from the overwintering pupæ and larvæ, occurred in such numbers that for a period it was almost impossible to work at the filter without getting some of them in the nose and mouth. In England a similar situation was reported by Kershaw (cited by Riley and Johannsen, 1932) with the same species, *Ps. alternata* and *Ps. phalænoides.* He pointed out that these species occur in such vast numbers as to be a nuisance to the vicinity, sticking to clothes, food, and lamps, and in some cases making breathing without swallowing them a difficult matter. If these species should prove capable of transmitting intestinal infections present in sewage material, they can be of considerable danger to the community. Although vague statements have been made as to danger from these flies, no adequate evidence has been presented.

Patton and Evans (1929) described a case of myiasis in a 3-year old boy due to the larvæ of *Ps. albipennis.* Invasion was suggested through ingestion of soil containing the larvæ; the larvæ probably migrated from the rectum to the bladder. Okada (1927) reported a case of gastric myiasis in a girl of 17 years caused by the ingestion of *Ps. b-punctata* Curtis.

Turner in 1923 demonstrated the feasibility of using *Ps. alternata* and *Ps. minuta* Banks as laboratory animals or as subjects for studies in heredity. Their short life cycle and great productivity and the ease with which they can be bred in natural media are chiefly responsible for making them ideal for breeding experiments.

In view of these facts, a systematic review of the genus is presented in this paper. The present status of these flies is systematically described so as to facilitate the determination of specimens.

This paper is based mainly upon the collections of the United States National Museum. The Museum of Comparative Zoölogy at Cambridge, the Cornell University collections at Ithaca, and the Canadian National Collections at Ottawa, Ontario, also contain valuable material.

To Dr. F. M. Root, recently deceased, I wish to express my sincere gratitude for the aid and interest so willingly given at all times, and for the many ways in which he has encouraged and guided me in my work. To Dr. J. M. Aldrich, also deceased, I am deeply indebted for the privilege of studying the material in the collection of the United States National Museum; and to Dr. A. Stone and Dr. H. Morrison, of the United States Bureau

of Entomology, for their valuable counsel, numerous suggestions, and for making available the necessary working facilities. It was my good fortune to be able to spend part of the time under Drs. O. A. Johannsen and J. C. Needham, of Cornell University, whose aid and assistance are greatly appreciated.

REVIEW OF THE SPECIES OF PSYCHODA OF NORTH AND CENTRAL AMERICA AND THE WEST INDIES

The genus *Psychoda* was erected in 1796 by Latreille, who placed it as the fourth in his family I of the Diptera. In this genus Latreille included *Tipula* Linnæus (Fabricius) (in part) and *Bibio* Geoffroy (Olivier) (in part) as synonyms. Latreille's definition of *Psychoda* is as follows:

> Antennes de la longeur des deux tiers du corps, de douze articles pyriformes, plumeux. Antennules longes, droites ou inclines, de quatre articles. Levres formant un bec pointu.
>
> Caracteres habituels. Tete petite, basse et arrondie; petits yeux lisses o. Ailes tres grandes, velvues, en toit.

The genus as originally defined did not include any species. In 1802 the same author recognized *Tipula phalænoides* Linnæus as the only representative of the genus *Psychoda*. Since no older designation of type for this genus is known and as it is a monotypic genus, *Tipula phalænoides* Linnæus is considered the type of the genus.

In 1904 Eaton divided the old genus into six smaller genera: *Philosepedon, Threticus, Logima, Telmatoscopus, Xenapates,* and *Clyticerus*. He characterized the old genus *Psychoda* as follows:

> Male antennae 14–16 jointed, with nodose flagellum composed of full-sized joints as far as the thirteenth joint of the antennae, followed by one, two, or three diminutive joints, and furnished with hair inserted upon the symmetrical or subsymmetrical nodes in verticils consisting of a series of 11 long-haired verticils closely moniliform, the eleventh including the diminutive joint or joints. Wings ovate-lanceolate, acute at the end of the median vein; subcosta very short and rudimentary, ending in the radius and not linked to the costa.

Tonnoir (1922) used Eaton's character of the structure of the tip of the antenna and concluded that the segment arising from segment 13 varies according to the individual, as Eaton believed. Tonnoir also used the presence or absence of hairs on the wing membrane or on the veins as a character. He proposed to reduce to subgenera the genera *Threticus, Logima, Philosepedon,* and *Xenapates*. In dealing with the North American and West Indian forms, it would be better to retain the old genus *Psychoda,* since, if we distribute the species in smaller genera, as proposed

by Eaton, or subgenera, as proposed by Tonnoir, it would evidently be necessary to establish new genera or subgenera peculiar to the North American continent.

The literature on the genus *Psychoda* in North America is scanty, although in Europe this genus has received the attention of such entomologists as Eaton and Tonnoir. Outside the work of Haseman (1907) little attempt at a comprehensive taxonomic study of this group has been made in this country, so that our knowledge of the number of species and of their distribution is very fragmentary. Haseman's treatise lists twenty-six species as belonging to the genus *Psychoda*. From Haseman's work, however, it has been difficult to decide whether some of his species belong to *Psychoda* or *Pericoma*. The location of Haseman's types is not known so that comparison of specimens could not be made. It is, therefore, somewhat difficult to state the exact number of species that Haseman described. In 1914 Banks published descriptions of two additional species of *Psychoda*. Curran in 1924 described four new species from Canada. Between that time and this there have appeared in various journals descriptions of some fifteen other species, four of which are from the West Indies and four from Central America.

Due to the great care that is necessary in preparing a collection of moth flies, specimens of them are usually rare in collections. Comparatively little is known of the distribution of the group on the North American continent. The forms that have been described have been collected in rather limited regions. Further collections in various areas will undoubtedly show that the number of undescribed forms is large.

Several workers who have dealt with this genus have recognized the difficulties encountered in the determination of the species and also the unsatisfactory nature of the descriptions given for the described species. The determination of the species is a rather difficult task, owing to the special technic necessary in the preparation of the specimens. For the study of such characters as the antennæ, wing venation, and genitalia, specimens cleared and mounted in the usual manner are not very satisfactory. To overcome this difficulty a number of methods of staining were tried, but the one that was most satisfactory and gave excellent mounts was the following: The specimen is immersed in 95 per cent alcohol for a few seconds,

placed in cold 10 per cent KOH, brought to a boil, washed in water, transferred to weak alcohol, brought up to absolute alcohol, equal parts of absolute alcohol and xylene, xylene and carbol-xylene with dissolved erythrosin (specimens may be left in this for an hour or more or overnight if the stain is diluted), transferred to clear carbol-xylene, then to balsam.

Careful examinations of prepared slides of the species that are apparently difficult to separate have been made in order that additional tangible characters may be utilized. Such characters as the structure of the tip of the labium or the tip of the paraglossæ have been found and used. It is hoped that these characters may be of value in the studies of this group of non-blood-sucking flies. Whether such characters will survive the test of wider application in the related groups remains to be determined.

As an aid in the search for little-known characters, which have been brought forth in the descriptive terminology used, and in order to have uniform measurements, the following explanations are given: The measurement between the eyes at the frons is taken at the place of least separation, unless otherwise mentioned; the width of the head is taken at its greatest width; the length of the wings is measured from the base of the costa, at the small semichitinous pad, to the tip; the width is taken at its widest part; the length of antenna is measured from the base of the first basal segment to the tip. All measurements mentioned in the paper are taken from slide preparations.

It will be seen that in the naming of the veins and cells of the wings the system introduced by Comstock and Needham has been employed. The merits and defects of this system of wing nomenclature are so well known that no justification for its use in this paper and for its deviation from the terminology of earlier workers is required. Although both Tillyard (1919) and Shannon and Bromley (1924) have proposed certain changes in the designation of certain veins in the above system, the terminology has not been elaborated. In the interest of uniformity and without causing any complication, the Comstock-Needham system will better fulfill the requirements. It has, therefore, been retained intact in the present systematic discussion. The terms used in this paper are given in text fig. 1.

Except for the structure of the tip of the labium or that of the paraglossæ, the characters used in preparing the synoptic key and in the discussion of the descriptions of the species are

chiefly those used in the literature and are usually self-explanatory. It has been the aim of the writer to center the discussion of specific characters on those which are of most importance in the identification of the species concerned or in its differentiation from those species with which it is likely to be confused in the North American fauna. Even the more obvious variations in the earlier descriptions in the literature are mentioned.

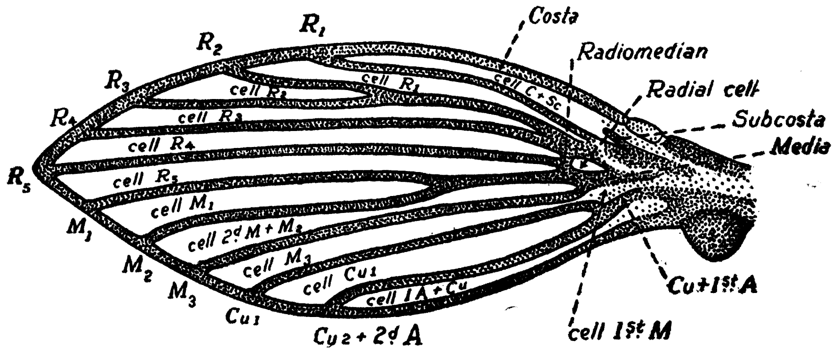

FIG. 1. Wing venation of *Psychoda*, showing terminology adopted for veins and cells.

The accompanying plates represent camera-lucida drawings by the author. It is a pleasure to acknowledge the generous assistance rendered by the National Museum artists of the Bureau of Science, Manila, Philippine Islands, in the preparation of the illustrations from the original drawings.

Synoptic key to the American species of the genus Psychoda.

1. Tip of labium not definitely enlarged, each lobe with long and short teeth at tip .... 2.
   Tip of labium (paraglossæ) definitely enlarged, each lobe with short spinelike teeth on the inner surface.......... 11.
2. Antennæ of sixteen segments .... 3.
   Antennæ of fourteen or fifteen segments.......... 7.
3. Last three segments of antennæ of reduced dimensions, about equal in size, all distinctly separated one from another.......... 4.
   Last three segments of antennæ of reduced dimensions, unequal in size, at least two of them intimately united.......... 5.
4. Ædeagus composed of two pieces, one broad with round end and one slender with pointed end; tip of labium with six teeth, four long and two short; inferior appendages of male bearing one spinule at about one-third the length of the appendage.......... *cinerea* Banks.
   Ædeagus composed of a single, long, tubular piece about one and one-half times the length of the inferior appendages; tip of labium with one short and four long teeth; inferior appendages of male bearing one long spinule at about two-thirds length of the appendage.
   interdicta Dyar.

5. Segments 13, 14, and 15 of the antennæ intimately united; 14 and 15 much wider than long, ovoid .... *marylandana* sp. nov.
   Segments 13, 14, and 15 of the antennæ not intimately united .... 6.
6. Segments 14 and 15 intimately united, both wider than long; 16 ovoid; sensory spine composed of two anterior branches and one posterior branch .... *grisescens* Tonn.
   Segment 14 intimately united with 13; 14 and 15 wider than long; sensory spine composed of three anterior branches and one posterior branch .... *pusilla* Tonn.
7. Antennæ of fifteen segments .... 8.
   Antennæ of fourteen segments .... 10.
8. Segment 14 distinctly separated from 13 and about equal in size to 15; tip of labium with two long and two short teeth, outer surface with two labial spines .... *phalænoides* (Eaton).
   Segment 14 intimately united to 13; 15 smaller than either 13 or 14; tip of labium with one short and four long teeth .... 9.
9. Tips of several veins of wing with small patches of black or dark brown hairs; wings with a mottled appearance; outer surface of tip of labium with three labial spines .... *alternata* Say.
   Tips of veins without these spots; wings uniformly grayish white; tip of labium with two labial spines; both forks of wing weakly chitinized .... *uniformis* sp. nov.
10. Wings without any markings; tip of labium with four labial spines; ventral plate not narrow near its base, lobes with rounded ends, their sides almost parallel .... *severini* Tonn.
    Wings with a black band; tip of labium with two labial spines; ventral plate narrowing near its base, lobes with pointed ends, their sides rather divergent .... *sigma* Kinc.
11. Sensory spines of antennæ with three branches, two anterior and one posterior .... 12.
    Sensory spines of antennæ not of this shape .... 15.
12. Inferior appendages with two terminal spinules, which are about two-thirds the length of the appendage; ædeagus with a long tubular piece, longer than the ninth tergite .... *opposita* Banks.
    Inferior appendages with one, three, or five terminal spinules, ædeagus without a long tubular piece .... 13.
13. Antennæ of sixteen segments; 16 small, united to 15; inferior appendages with five terminal spinules; ædeagus with two lateral pieces triangular .... *bishoppi* sp. nov.
    Antennæ of sixteen segments; last four separated from each other by short necks; last three nearly of the same size .... 14.
14. Inferior appendages with a single, long, clavate spinule; forks of wing not loosely chitinized .... *fumata* Knab.
    Inferior appendages with three long spinules; both forks of wings loosely chitinized .... *tridactila* Kinc.
15. Antennæ of sixteen segments; last three segments small, with or without a small blunt end or toothlike projection .... 16.
    Antennæ of sixteen segments; last segment large, with a long slender spike .... 19.

16. Last three segments of antennæ of about equal size; distinctly separated from each other; last segment without a blunt end or toothlike projection, lemon-shaped .... 17.
Last three segments of antennæ of unequal size; last segment with either a blunt end or a toothlike projection........ 18.
17. Sensory spines composed of two long branches, one anterior and one posterior; inferior appendages with three terminal spinules; ædeagus composed of three pieces........ *bicolor* Banks.
Sensory spines composed of two, broad, leaflike branches; inferior appendages with two terminal spinules, length about two-thirds of the appendages; ovipositor of female composed of a broad plate with a blunt end .... *helicis* Dyar.
18. Last two segments of antennæ of equal size; last segment with a blunt end; sensory spines composed of two, slender, leaflike branches; inferior appendages with thirteen to fifteen spinules; ædeagus pedunculately subovate .... *olympia* Kinc.
Last two segments of antennæ of unequal size, last segment with a toothlike projection; sensory spines comblike; third segment of antennæ with a subnode; inferior appendages with three spinules, edges serrated; ædeagus composed of three curved pieces.
snowhilli sp. nov.
19. Sensory spines of antennæ fingerlike in shape, continuous round the node in male; with four or five branches in female; wings (male) heavily pigmented or with scalelike hairs near the base........ 20.
Sensory spines with one or two anterior branches; wings not heavily pigmented .... 22.
20. Wings heavily pigmented, giving a mottled appearance; legs annulated.
autumnalis Banks.
Wings not heavily pigmented; legs not annulated........ 21.
21. Wings with black and white hairs on the whole surface; black spots on tips of almost all veins; paraglossæ toothless.
quadripunctata Banks.
Wings without black and white hairs on the whole surface; male with scalelike hairs on the undersurface near the base; ædeagus clawlike, with a posterior plate having a notch at its tip.... *nigra* Banks.
22. Upper fork of wing distinctly before lower; segment 16 of antennæ without fingerlike projections near base of spike; ædeagus shaped like a tennis racket........ *albipunctata* Will.
Forks nearly at same level; segment 16 of antennæ without fingerlike projection .... 23.
23. Sc ending before level of r-m; sensory spines of antennæ composed of a single branch; tergite IX with one spiracular opening.
superba Banks.
Sc ending at the level of r-m; sensory spines composed of two branches; tergite IX with two spiracular openings.
superba var. *conspicua* var. nov.

SPECIFIC DESCRIPTIONS

PSYCHODA ALTERNATA Say. Plate 1, figs. 1 to 5.

Psychoda alternata SAY, Long's Exp. St. Peter's River, App. (1824) 358.
Tipula phalænoides var. SCOP., Ent. Carn., No. 864 (1763) 324.
Trichoptera phalænoides MEIG., Klassif. d. Zweifl. 1 (1804) 43.
Psychoda phalænoides MEIG., System. Beschr. ed. 1 (1818) 104.
Psychoda sexpunctata CURTIS, Brit. Ent. 16 (1839) 745.
Psychoda marginepunctata ROSER, Corr. Wurt. landw. Ver. 1 (1840) 50.
Psychoda schizura KINCAID, Ent. News 10 (1899) 32.
Psychoda floridica HASEMAN, Trans. Am. Ent. Soc. 33 (1907) 316.
Psychoda nocturnala HASEMAN, Trans. Am. Ent. Soc. 33 (1907) 319.
Psychoda bengalensis BRUNETTI, Rec. Ind. Mus. 11 (1908) 370.
Psychoda albimaculata WELCH, Ann. Ent. Soc. Am. 5 (1912) 411.
Psychoda dakotensis DYAR, Insec. Inscit. Menst. 14 (1926) 107–110.

Male.—Occiput yellowish brown, border lighter, covered with long straight hairs varying from yellowish gray to white, in certain lights black. Eyes at frons separated by a distance equal to about the diameter of two facets. Frons and clypeus together triangular, yellowish brown, with a brush of whitish gray hairs. Proboscis about one-half the length of the head, covered with gray pruinescence. Tip of labium with four long teeth and one short tooth on each side, the latter about one-half the length of the former. In ordinary mounts the number and shape of the teeth cannot be made out easily, but if dissected and mounted under a separate cover glass the longest and the shortest teeth are found to be typically curved, with the tip more or less rounded. The longest teeth have an average length of 11.4 μ; the shortest an average length of 5.7 μ. Tip of the labium also provided with three spines on each side. Subequal in length, the longest about twice the length of the shortest teeth. Fine, slender hairs and microtrichia cover the whole surface of the labium. Palpi whitish yellow, about three times longer than the proboscis; first segment more yellow, about the same length as the second and third segments, provided with verticil hairs near the middle; second segment pale yellow towards the tip; third segment again pale yellow, greatly thickened distally; fourth with extreme apex whitish, slender, longer than any of the basal three segments. Antennæ whitish except for the first yellow basal segment; length equal to the width

of the wings; fifteen segments; segment 1 cylindrical, distinctly larger than any of the other segments, 2 more or less spherical, both 1 and 2 clothed with numerous fusiform scales as well as whorls of strong hairs; segments 3 to 12 flask-shaped, basal nodes about the same length as the adjacent slender clear internodes, over twice as wide as the diameter of the internodes, nodes each with four to five whorls of long white hairs projecting distally beyond the node of the adjacent distal segment; segment 14 one-half longer than 13, separated by a shallow weak constriction, coating of hairs similar to that of the middle segments; segment 15 small, ovoid, about one-half the length of 14; segments 14 and 15 closely joined. Antennal segments except the two basal and two apical each provided with two sensory spines (ascoid of Tonnoir), diametrically opposed. Each sensory spine with two well-developed anterior branches directed distad and slightly curved, and a posterior branch, slender, and in some basal segments much reduced. In the last segment of the antennæ the sensory spines are star-shaped with three branches, almost equal in length.

Thorax yellowish brown, thickly clothed with long, erect, mingled white and gray hairs. Wings ovate, rather pointed at extremity, thickly coated with alternate white and black patches of erect hairs on upper surface, moderate coating on lower surface. Mottled appearance arranged about as follows: (*a*) Black spots at tips of veins R_1, R_2, R_3, R_4, M_1 M_3, and $Cu_2 + 2d\ A$; (*b*) a wide black strip suffused with dull yellow with indications of a distinct transverse black band at basal third of wing, the inner deflection extending into basal one-fourth of vein Cu_1 forming a distinct black tuft, the outer deflection extending into middle of vein $Cu_2 + 2d\ A$; (*c*) indications of black band in middle region of wing formed by black spots on basal half of R_2, basal two-thirds of R_3, basal two-thirds of R_4, M_1, and M_3; (*d*) white spots occupying all intermediate spaces on surfaces between black spots. Fringe on wing margin smoky, anterior fringe about one-third width of wing, posterior fringe about one-half width of wing. On ventral surface the hairs are short, dull yellow, and reclined. Sc short, gently arcuate, as long as Rs. Origin of $R_2 + R_3$ on the same line as r-m. Fork R_2 R_3 at about four-fifths of the wing length. Fork M_1M_2 at about three-fifths the wing length, a little closer to fork $R_2 + R_3$ than to r-m. Halteres white with a yellow stem. Legs pale yellow to whitish; coxæ, trochanters, and femora yel-

lowish; fore tibiæ with dorsal side dark brown; middle and hind femora whitish, dorsal side with several stout, dark brown, scalelike hairs; tarsal segments except for the white speckling usually darker, ventral surface, especially of the middle and hind pairs, partly or almost completely covered with short, prostrate, whitish, scalelike hairs. All feet provided with small, equal, and untoothed claws.

Abdomen reddish brown, dorsal surface of tergum towards base paler than the remaining parts. Each abdominal segment thickly clothed dorsally with a ringlike series of mingled white and gray erect hairs; ventral surface covered with fine, slender, whitish hairs. Hypopygium yellowish brown, ninth tergite (basis of Haseman) well developed, longer than the eighth tergite, about as long as broad, slightly broader at caudal end; inferior appendages (cercopods of Tonnoir), swollen at base, gradually tapering, slightly curved, about twice as long as the ninth tergite, heavily fringed with grayish white, erect hairs towards base; terminal spinule (tentacles of Eaton) about onetenth length of appendage, flat, wider at the apex. Superior appendages (gonopods or forceps of Tonnoir) with two subequal segments, the first one strongly developed, with a bump in the middle on its outer face; the second segment sickle-shaped, a little longer than the first, slightly expanded inward at the middle, its tip pointed, slightly curved. Ædeagus constructed of two subequal parts.

Length of body, 1.40 mm; width of head, 0.40 mm; length of wing, 1.60; width of wing, 0.60; length of antennæ, 1.20.

Female.—Distinctly larger than the male; head and thorax slightly more yellowish brown; abdomen slightly brown, whitish towards base. Antennæ slightly shorter than in male, basal two segments yellowish brown, middle segments grayish white, the three apical segments slightly more grayish; nodes notably longer than the internode, as long as broad; sensory spines well developed and strongly curved. Thorax robust, dull yellowish brown, more densely coated with thick white and gray hairs. Arrangement of spots in wing as in the male but the spots are much darker. Abdomen considerably more developed than in the male, as densely clothed as the thorax, with similar thick bristlelike hairs. Ventral plate yellowish brown, U-shaped. Ovipositor darker than the plate, twice as long as plate, consisting of two pieces loosely compressed laterally, pointed, curved upward.

Length of body, 1.50 mm; width of head, 0.50; length of wing, 1.70; width of wing, 0.80; length of antennæ, 1.00.

ILLINOIS, Chicago, October 25, 1912 (Welch's types of *albimaculata*). WASHINGTON, Seattle, September 1, 1898 (Kincaid's cotypes of *schizura*). NEW HAMPSHIRE, Franconia (*Mrs. A. T. Slosson*). MARYLAND, Plummer's Island, August 14, 1902 (*H. S. Barber*); Cabin John Bridge, June 17, 1928 (*H. G. Dyar*); Baltimore, December 12, 1932 (*F. M. Root*); Back River, June 20, 1922 (*F. M. Root*); College Park, August 26, 1933 (*F. C. Bishopp's* light trap); Towson, May 7, 1924 (*F. M. Root*); Baltimore, December 12, 1932 (*F. del Rosario*). VIRGINIA, Falls Church, June 7, 1914 (*R. S. Shannon*). PENNSYLVANIA, Allentown, November 17, 1915 (*P. A. Mader*). NEW MEXICO, Las Vegas, September, 1894 (*T. D. A. Cockerell*); Las Cruces, September, 1894 (*T. D. A. Cockerell*). TEXAS, El Paso, October, 1923 (*R. E. Tarbett*), "Suspected of carrying fever." KANSAS, Lawrence (*J. M. Aldrich*). OHIO, Dayton, July 6, 1928 (*G. Goodhue*). MONTANA, St. Charles, 1926 (*M. J. Brown*). CALIFORNIA, Palm Springs, March 24 to 26, 1918 (Cornell University collection). DISTRICT OF COLUMBIA, Washington, November, 1909 (*H. S. Barber*).

Reported also from Calcutta, India, March 4, 1913 (Baker's collection, cotypes of *bengalensis* Brunetti); Madeira, February, 1925 (*T. D. A. Cockerell*); Olaa, Hawaii (*W. H. Ashmead,* 2,000 feet elevation); Brookings, South Dakota (*J. M. Aldrich,* type specimens of *dakotensis* Dyar).

This species is evidently very widespread and cosmopolitan. Haseman reported it as occurring throughout the United States.

Tonnoir considers *tripunctata* Macquart as a synonym of *alternata* Say, but I cannot agree with him. Macquart's figure (pl. 12, fig. 2) shows that the fork of R_2R_3 in the wing is much closer to the base than the fork of M_1M_2; the wing shows four longitudinal veins after the second forking; the length given is 3 to 4 lines, or about 6 to 8 mm, which is unusual for a *Psychoda.*

Psychoda alternata and the following nine species are members of a group possessing long and short teeth at the tip of the labium. In this group the lobe of the tip of the labium is not expanded into a bulblike structure and each lobe possesses not more than four labial spines. *Psychoda alternata* is easily recognized by the mottled appearance of the wing and the peculiar structure of the tip of the antennæ, which is very distinctive.

PSYCHODA PHALÆNOIDES (Linnæus, 1758) Tonnoir. Plate 1, figs. 6 to 10.

Psychoda phalænoides (Linnæus, 1758) TONNOIR, Ann. Soc. Ent. 62 (1922) 67–68.

Tipula phalænoides LINNÆUS, Syst. Nat. ed. 10 No. 32 (1758) 588.

Psychoda pacifica KINCAID, Ent. News 8 (1897) 143.

Psychoda tonnoiri DYAR, Insec. Inscit. Menst. 14 (1926) 105.

Male.—Occiput brown, clothed with long yellowish gray hair. Eyes at frons separated by a distance equal to about the diameter of one facet. Frons and clypeus together are triangular with rounded corners, brown, covered with erect, whitish hairs. Proboscis about one-half the length of the frons and clypeus combined, light brown, with golden pubescence. Tip of labium with three long teeth and one short tooth on each side of the lobe. The shortest is slightly pointed and is about one-half the length of the longest teeth. The longest teeth have an average length of 9 μ, the shortest an average length of 4.6 μ. Tip of labium with two prominent straight spines subequal in length. Palpi gray, about four times longer than proboscis; first segment darker, about the same length as the fourth segment; second and third segments decidedly gray, of about the same length, with more verticil hairs, especially in the middle; fourth segment grayish white, slender, longer than second or third segment. Antennæ brown, as long as width of wing; fifteen segments; segment 1 cylindrical; 2 globular, closely applied to segment 1, both 1 and 2 with verticillate grayish white hairs and fusiform scales; segments 3 to 12 flask-shaped, basal nodes spherical, distinctly shorter than their adjacent internodes; nodes covered with five or six whorls of grayish white hairs reaching as far as the adjacent distal internodes; segment 13 of about the same size as segment 12, but not provided with the internode. Segments 14 and 15 of about the same length, distinctly separated from each other and from 13; 13 and 14 each with a small protuberance toward the anterior side bearing a short pointed spine. One pair of ascoids present on all the segments except on the two basal and the two terminal segments; they are bifurcate with a basal appendage slightly smaller and shorter.

Thorax brown, covered with thick bristly, grayish white hairs, with some darker hairs intermixed. Wings ovate-lanceolate, slightly obtusely rounded at apex, very pale gray, nearly clear round the posterior border. Veins with the usual row of gray hairs, with some darker, nearly erect hairs placed in irregular

rows and patches near the base of the wing; a small bunch of dark bristly hairs at the base. Costal border clothed to the tip of the wing with stiff gray hairs; toward the wing base the wing fringe becomes darker; fringe at the posterior margin toward the base becomes smoky gray and from thence towards the border to the tip of the wing the fringe becomes grayish white. Sc about one-third longer than the semichitinous pad above it and equal to about three-quarters the length of Rs. Origin of $R_2 + R_3$ on R_4 distinctly after fork of Rs. Fork $R_2 + R_3$ at middle of wing length; fork M_1M_2 a little beyond middle of R_2R_3, a little closer to fork R_2R_3 than to r-m; tip of R_1 slightly beyond level of tip of $Cu_2 + 2d$ A. Halteres whitish gray with few appressed gray hairs; knob about one-half length of stem. Legs of uniform coloration similar to that of the body; femora and most of tibiæ with whitish gray hairs, distal third of tibiæ and tarsal segments darker when seen in certain positions, latter covered with short, broad, somewhat prostrate, white hairs, appearing as scales.

Abdomen darker than the thorax except for the dorsum which is paler; dorsum with thick, erect, whitish gray hairs; hairs on the lateral margins more or less reclined. Hypopygium pale brown, surrounded by long gray hairs. Ninth tergite about as long as eighth tergite, slightly distended in the middle portion; longer than broad. Inferior appendages about twice as long as the ninth tergite, slender, curving ventrally, swollen slightly near base and gradually tapering toward an acute point; terminal spinule minute, clavate, much wider towards the apex. Superior appendages 2-segmented; basal segment swollen near base; second segment almost as long as the basal, slender, tapering to an acute point, with short and weak spines above and below. Ædeagus about as long as second segment of superior appendage, rather tubular, basal half broad, rounded at tip.

Length of body, 1.50 mm; width of head, 0.30; length of wing, 0.50; width of wing, 0.60; length of antennæ, 0.90.

Female.—Similar to the male. Eyes at frons not as close as in the male. Proboscis less than half the frons and clypeus combined. Antennæ shorter than in the male, but the form and shape of the terminal segments identical. Abdomen darker than in the male, but the hairs not so uniformly distributed. Ventral plate brown, with numerous gray hairs and several scattered straight hairs, nearly twice as long as broad, ending posteriorly in two rounded lobes with deep emargination between them; ovipositor of same color as ventral plate, slightly

curved upward, with a few scattered spines along margin of basal third.

Length of body, 1.70 mm; width of head, 0.40; length of wing, 2.00; width of wing, 1.00; length of antennæ, 1.30.

IDAHO, Moscow (*J. M. Aldrich*, two specimens, one bearing a label *cinerea* Banks). CALIFORNIA, Stanford University, February 2, 1906 (*J. M. Aldrich*); Eureka, May, (*H. S. Barber*); Fieldbrook, May 18, 1903 (*H. S. Barber*); Summit, May 15, 1921 (*H. S. Barber*); Pasadena, February 24, 1909 (*F. Grinnell*). WASHINGTON, Seattle, March 22, 1898, (Kincaid's cotypes of *pacifica*); Longmire Springs, June 10 and 11, 1917 (*H. G. Dyar*). DISTRICT OF COLUMBIA, Washington, May 20, 1905 (*H. S. Barber*). ALASKA, St. Paul Island (Kincaid's cotypes of *pacifica*). BRITISH COLUMBIA, Lowes Inlet, 1899 (*Harriman Expedition*, Kincaid's cotypes of *pacifica*). ALBERTA, Banff, July 15, 1918 (*H. G. Dyar*). NEW MEXICO, Las Vegas, August 19, 1907 (*H. S. Barber*). WISCONSIN, Beloit (*C. L. Turner*). COLORADO, Grand Lake, June 20, 1923 (*H. G. Dyar*). MARYLAND, College Park, August 26, 1933, September 19, 1933 (*F. C. Bishopp's* light trap); Baltimore, November 6, 1932 (*F. del Rosario*).

The synonymy given above is based upon that published by Latreille, Kincaid, and Dyar. The description given by Latreille relates largely to characters of a general nature, and details that, in the light of our present knowledge of the members of the group, are of little value in separating it from other species. Kincaid's description of *Ps. pacifica* agrees so closely with Tonnoir's description of *Ps. phalænoides*, especially as to the segments of the antennæ, and with his cotypes at my disposal, that I have no hesitation in placing it as a synonym of the latter species. Dyar (1926), in his description of the psychodids from the Glacier National Park, recognizes the *phalænoides* of Eaton and Tonnoir, not of Linnæus, as *tonnoiri*, and has interpreted Linnæus's *phalænoides* as the "common or official" form. Dyar's long list of synonyms includes *Ps. degenerans* Walker, *Ps. cinerea* Banks, *Ps. minuta* Banks, *Ps. pallens* Williston, *Ps. pacifica* Kincaid, *Ps. elegans* Kincaid, *Ps. longifringa* Haseman, *Ps. domestica* Haseman, *Ps. severini* Tonnoir, and *Ps. prudens* Curran. Curran 1930 (1931) believes that Dyar was wrong when he included *Ps. prudens* as a synonym of *phalænoides*, since the male genitalia are very different in the two species. In the same paper Curran states:

Dyar would upset the work of Tonnoir in regard to the name of our common species and would call *phalaenoides* Tonnoir *Ps. tonnoiri*. This, of course, he has no right to do, since Tonnoir was the first to revise the species, and he had a perfect right to limit the name *phalaenoides* in what seemed to him the proper way. Dyar has merely complicated matters and added another name to the synonymy of *phalaenoides*. If Dyar's synonymy for his *phalaenoides* is correct, the proper name for our North American species would be *degenerans* Walker but, inasmuch as we are certain of the identity of *cinerea* Banks and know nothing of *degenerans*, I have used that name. I do not, however, think that all the names placed in the synonymy by Dyar belong there and a thorough study of the genus will probably prove that there are several species concerned. Dyar's suggested synonymy throughout the family needs verification and should be seriously considered at the present time.

PSYCHODA CINEREA Banks. Plate 1, figs. 11 to 15.

Psychoda cinerea BANKS, Can. Ent. **26** (1894) 331.
Psychoda elegans KINCAID, Ent. News **8** (1897) 144.
Threticus compar EATON, Ent. Mo. Mag. II **15** (1904) 57.
Psychoda domestica HASEMAN, Ent. News **19** (1908) 285.
Psychoda compar (Eaton) TONNOIR, Ann. Soc. Ent. Belg. **62** (1922) 67–69.
Psychoda prudens CURRAN, Can. Ent. **46** (1924) 219.

Male.—Occiput light brown, covered with short grayish brown hairs. Eyes at frons separated by a distance equal to the diameter of one facet. Frons pale brown, rather kidney-shaped, clothed with straight and slightly curved bristly hairs, brush appearing dark when viewed from above and yellowish brown when seen from the sides. Clypeus hexagonal, with its widest side forming a distinct suture which separates it from the frons. Proboscis pale yellow, slightly longer than the first palpal segment. Tip of labium provided with six teeth and five spines. Teeth arranged about as follows: First about two-thirds length of second and about a third longer than the fourth, which is the shortest; second and third of about same length as the fifth and sixth, their distal ends rounded. The spines are arranged as in *Ps. phalænoides* or *Ps. severini*. The clothing of hairs around the teeth much thinner and microtrichia much longer than in *phalænoides, severini*, or *alternata*. Palpi about four times the length of proboscis, light brown, with short whitish hairs; first segment shortest, cylindrical; second barely longer than the first, nearly club-shaped; third slightly longer and broader than the second; fourth the longest, slightly tapering to a sharp point. Antennæ 16-jointed, one and a half times the width of the wing, nodes light brown, with grayish hairs appearing of equal width throughout the whole length of the antennæ; basal segment almost as broad as long, distended at

middle portion on one side, covered with brown whorls of hairs; segment 2 spherical, smaller than 1 and like the basal segment with brown whorls of hairs; segments 3 to 12 with nodes slightly enlarged, shorter than the internodes, whorls of grayish hairs on each node; segment 13 with a distinct rather short neck; segments 14 to 16 much reduced, slightly broader than long, closely applied to each other. Sensory spines seen in segments 3 to 13 are of the usual type with two long anterior branches and a slender and slightly shorter posterior branch.

Thorax pale yellowish brown, anterior margin of dorsum clothed with a thick brush of gray and blackish hairs; pleuræ bare except for a few yellowish gray hairs at the base of the root of the wing. Wings acutely pointed, with cinereous hairs on the veins. Semichitinous pad at base of costa blackish with gray hairs; fringe on anterior margin smoky, shorter than that on posterior margin. Bases of veins on the lower surface of the wings highly chitinized. Sc short, about one-third longer than the semichitinous pad above it. End of R_1 a little beyond middle of wing. Origin of $R_2 + R_3$ distinctly before level of r-m. Fork M_1M_2 much closer to either origin of R_2R_3 or r-m than to fork R_2R_3. Base of halteres white, knob grayish white. Legs light brown, femora and tibiæ with appressed, long, gray hairs above, rather silvery gray or dark in certain lights; tarsal segments with appressed, white, scalelike hairs; claws of moderate size, equal and simple as in other members of this group.

Abdomen light brown on dorsum, lateral margin dull white. Tergites, except the last three or four, clothed with a thick set of gray hairs intermixed with long pale silvery hairs; hairs on pleuræ yellowish, rather fine. Hypopygium pale brown, covered with whitish hairs. Ninth tergite about as long as broad, slightly wider at basal one-third. Inferior appendages nearly as long as the ninth tergite, club-shaped, swollen at basal two-thirds, tapering towards the end; terminal spinule cylindrical, somewhat curved inwardly, about one-third as long as the inferior appendages. Basal segment of superior appendages stout, swollen at middle portion; distal segment over one-half as long as basal segment, slender, slightly enlarged at basal one-third; distal portion gently tapering to an acute point. Second segment of superior appendages with a single, long, slender spine or bristle. Ædeagus composed of two processes, one rather broad before the middle, its margin somewhat folded on one side, with a rounded point, the other about as long as

the first, intimately attached to the first at its base, tapering to a sharp point.

Length of body, 1.20 mm; width of head, 0.30; length of wing, 1.60; width of wing, 0.70; length of antennæ, 1.20.

Female.—In coloring like the male, but the pleura of the intermediate abdominal segments distinctly whiter. Second antennal segment much broader than long. Area immediately below the base of the root of the wing pale yellow. Hind tibiæ and first tarsal segment with long grayish hairs more pronounced than in the male. Anterior margin of the knob of the halteres white. Ventral plate light brown, with short, gray, appressed hairs, much broader than long, slightly emarginate, ending distally in two semicircular lobes. Ovipositor reddish brown, shining, slightly curved.

Length of body, 1.70 mm; width of head, 0.40; length of wing, 1.80; width of wing, 0.80; length of antennæ, 1.00.

NEW YORK, Long Island, Banks's type, *4311 U. S. Nat. Mus.* (types of *cinerea,* two specimens); Ithaca, March 27, 1933, April 10, 1933 (*F. del Rosario*); Brooklyn June 11, 1912 (*A. C. Weed*). WASHINGTON, Seattle, March 22, 1898 (Kincaid's cotypes of *elegans*). DISTRICT OF COLUMBIA, Washington, May 10, 1911 (*F. K. Knab*). MASSACHUSETTS, Cambridge, May 1870 (no label for collector). INDIANA, Lafayette, April 20, 1915 (trap lantern, collector unknown). VIRGINIA, Richmond, 1920 (*Wm. D. Richardson*); Glencarlyn, May 9, 1909 (*F. K. Knab*). MARYLAND, Plummer's Island, May 16, 1909 (*F. K. Knab*); Cabin John Bridge, May 16, 1909 (*F. K. Knab*).

This is evidently the species that Tonnoir described as *Ps. compar* Eaton. Tonnoir's figures of *compar* agree exactly in the more important structural characters with the type of *cinerea.* An unpublished figure of the male genitalia of *Ps. prudens* Curran, kindly presented to me by Doctor Curran, agrees very well with the male hypopygium of *cinerea,* so that I do not hesitate to place it here as a synonym.

In general appearance this species is very similar to *phalænoides* or *severini,* but the number of segments of the antennæ, the arrangement of the last three antennal segments, the number of teeth at the tip of the labium, and the structure of the male genitalia at once distinguish it.

PSYCHODA SEVERINI Tonnoir. Plate 1, figs. 16 to 21.

Psychoda severini TONNOIR, Ann. Soc. Ent. Belg. 62 (1922) 78–81.

Psychoda phalænoides (Linnæus, 1758) DYAR, Insec. Inscit. Menst. 14 (1926) 105.

Male.—Occiput brownish, with erect yellowish gray hairs. Eyes separated by a distance equal to about the diameter of two facets. Frons and clypeus combined triangular, brown, with pale brownish yellow, bristly hairs. Proboscis about two-thirds as long as the frons and clypeus combined, rather broad at base, tapering into a sharp point, yellowish brown with gray hairs. Tip of labium with four long teeth and one short tooth, first tooth about as long as the fourth, third tooth longest and about twice the length of the shortest; the longest with an average length of 12 μ; the shortest with an average length of 6.1 μ; the tip of the labium is provided with four labial spines arranged about as follows: One about twice the length of the tooth lying below the bases of the second and third teeth; second of about same length as the first, lying below the fourth tooth; third and fourth much shorter and closer to the margin. Fine slender hairs and microtrichia covering the whole surface of the tip of the labium, very distinct. Palpi yellowish gray, palpal segments of same length except the fourth which is longer by about the length of the third or second segment. Antennæ light brown, surrounded by yellowish gray bristly hairs. Verticils of yellowish gray hairs lying closely to the segments, directed forwards, clustering together, giving the antennæ a somewhat solid appearance with parallel sides; first basal segment short, cup-shaped, second segment much broader than long, both segments encircled by leaflike hairs; segments 3 to 12 flask-shaped, nodes much broader than long, distinctly shorter than adjacent internodes, whorls of hairs like those of *Ps. phalænoides;* segment 13 with a short neck bearing on one side and close to the base of 14 a toothlike projection armed with a single short spine; 14 small, ovoid. Sensory spines similar to those of *phalænoides;* they are not found on the first two basal segments or on the last segment.

Thorax light brown, covered with long, pale yellowish gray, bristly hairs, plentifully intermixed with almost white hairs. The hairs on the anterior border of the dorsum show a tendency to be arranged in bushlike sets, on the posterior border they are arranged in three rows, the middle row arranged in fan-shaped sets parted in the middle; the rows on each side of the middle row are made up of long and short, erect hairs. Pleuræ brown, shining, bare or nearly so. Wings rather broad, with apex somewhat rounded, having the appearance of being pale gray, wholly unmarked; veins distinct, each with the usual double row of hairs, which appear dark when viewed from above

and white when viewed horizontally from the tip of the wing. Hairs on the semichitinous pad along base of costa, long, thickly set, nearly black. Sc barely longer than the semichitinous pad above it. Fork of R_2R_3 at middle of wing length, a little beyond level of tip of R_1. Origin of $R_2 + R_3$ on the same level as r-m. Fork of M_1M_2 a little closer to fork of R_2R_3 than to r-m. Halteres clothed with gray hairs on the knob and with grayish white appressed hairs on the stem. Legs light brown, femora with some whitish hairs below, the tibiæ rather closely covered with grayish white hairs, the tarsi with white hairs which, towards the tip, are replaced by small elongated white scales.

Dorsum of abdomen brown, lateral margin lighter, clothed with yellowish gray hairs, a thick set of hairs on the dorsum of first abdominal segment. Towards the genitalia the hairs are arranged in fan-shaped sets. Hypopygium light, with long bristly hairs. Ninth tergite longer than broad, a little broader toward the distal portion. Inferior appendages one and one-half times longer than the ninth tergite, basal fourth swollen and rounded externally, gradually tapering towards the end where it carries a short, rather spatulate, spinule; superior appendages 2-jointed, proximal segment somewhat stout, middle portion slightly enlarged, distal segment slightly swollen at the base and with the distal half provided with one long spine and several short ones, gently undulating, their apex moderately pointed. Ædeagus formed of two, long, sharply pointed processes, one rather longer than the other and somewhat broader before the middle, the other curved gently from basal third.

Length of body, 1.20 mm; width of head, 0.30; length of wing, 1.60; with of wing, 0.70; length of antennæ, 1.40.

Female.—In coloring like the male. Proboscis less than two-thirds the length of the frons and clypeus combined. Teeth on the tip of the labium rather more prominent but their size and shape as in the male. Last segment of the antenna without a toothlike projection near its base. Hair on the dorsum of the thorax arranged in about the same fashion as in the male. Abdomen as in the male but the lateral part of the dorsal conjunctiva, the first tergite, and all sternites, except the last two or three, light brown. Wings not as broad as in male, showing a tendency to be less rounded at apex. Fork of R_2R_3 slightly before the middle of the wing. Fork of M_1M_2 just as close to fork of R_2R_3 as to r-m. Ventral plate with two pronounced lobes, the depth about one-third the distance between the two

lobes; the external surface is covered with strong spines and microtrichia.

Length of body, 2.40 mm; width of head, 0.40; length of wing, 2.50; width of wing, 1.10; length of antennæ, 1.10.

BRITISH COLUMBIA, Kaslo, June (*R. P. Currie, H. G. Dyar*). NEW MEXICO, Las Cruces (*T. D. A. Cockerell*). DISTRICT OF COLUMBIA, Washington, May 16, 1911 (*F. K. Knab*). CALIFORNIA, Eureka, May (*H. S. Barber*). MARYLAND, Plummer's Island, April, May (Schwarz collection). MONTANA, Glacier National Park, July, August (*H. G. Dyar*). ENGLAND, London, July 27 (*Brunetti,* 1888).

This species was originally described in 1922 by Tonnoir. In 1926 Dyar remarked—

> Tonnoir . . . described as new the common 14-jointed antennal form as *severini*. We think that when other indication is lacking Linnæus species should be taken to be the "common or official" form, and we have therefore interpreted *phalaenoides* in this sense.

Dyar's attempt to solve the problem indicates that he was not aware of the fact that Tonnoir was the first reviser and naturally had the right to interpret the naming of the species.

PSYCHODA PUSILLA Tonnoir. Plate 2, figs. 1 to 5.

Psychoda pusilla TONNOIR, Ann. Soc. Ent. Belg. 62 (1922) 83–84.

Male.—Occiput dull brown, covered with slightly curved gray hairs. Eyes at frons separated by a distance equal to about two and one-third times the diameter of one facet. Frons and clypeus together triangular, brown, with light gray hairs. Proboscis well developed, shiny brown, with gray pruinescence, one-half the width of the head. Tip of the labium with three long teeth and one short tooth, the latter about one-half the length of the former. On each side of the tip of the labium are two long spines subequal in length, microtrichia, and fine slender hairs, which are more prominent along the margin. Palpi pale brown, with whitish yellow hairs; palpal segments are in the proportions of 15 : 12 : 13 : 18. Antennæ of sixteen segments, brown, with gray whorls of hairs, about twice the width of the wing; segment 1 cylindrical, distinctly larger than any of the other segments; 2 spherical; segments 3 to 12 flask-shaped, basal nodes a little less than one-fifth shorter than the adjacent internodes, about three times larger than the diameter of the internodes; whorls from nodes barely reaching the node of distal adjacent segment; segment 13 of about the same diameter as

the middle segments and very intimately united with 14, which is about one-third its size; segment 15 much wider than long, also intimately connected to 14; segment 16 almost spherical, with indication of a neck separating it from 15. Antennal segments 3 to 13 each provided with a pair of sensory spines diametrically opposed; each sensory spine shaped like a fork with three slender branches directed anteriorly and a short branch directed posteriorly.

Thorax brown, with gray hairs more pronounced on the anterior margin of the dorsum. Wings ovate, broad, rather pointed at apex, uniformly clothed with smoky gray hairs; hairs of posterior fringe longer and more erect than those of the anterior. Sc a third longer than the semichitinous pad above it. Origin of $R_2 + R_3$ on the same line as r-m. Fork of R_2R_3 about the middle of wing; before the extremity of $Cu_2 + 2d$ A, weakly chitinized. Fork of M_1M_2 almost as near to r-m as to fork of R_2R_3, also very weakly chitinized. Vein R_5 well developed and heavily chitinized. Halteres yellowish white with microtrichia and short gray hairs; stem much shorter than the knob. Legs about the same color as body; hairs covering them somewhat lighter than on body; middle and posterior tibiæ each with a row of long, erect, spinelike hairs on its inner and outer surfaces; those on the middle portion of the segments longest, and those of the outer row longer than those of the inner; femur and tibiæ rather sparingly clothed with closely applied hairs; tarsi covered with light scalelike hairs which appear white in reflected light.

Abdomen pale brown, lateral membrane dusky, posterior margins of segments darker brown. Each abdominal segment with short, erect, scattered grayish hairs. Hypopygium yellowish brown; ninth tergite well developed, nearly circular when viewed from above; caudal end with a triangular flap. Inferior appendages slender, slightly swollen at base and gradually tapering. Terminal spinule flat and wider at apex, about one-fourth of the length of inferior appendages. Basal segment of the superior appendages strongly developed, stout, slightly swollen at the middle; distal segment almost as long as the basal segment, slender, slightly curved, tapering to an acute point and bearing a few groups of spines. Ædeagus formed of two processes, one stout, rather tubular, slightly distended in middle and with round apex; the other slender, curved, ending in a sharp point. The two processes are united at their bases.

Length of body, 0.90 mm; width of head, 0.27; length of wing, 0.98; width of wing, 0.38; length of antennæ, 0.80.

Female.—Similar to the male in coloring and in structure of the antennæ, tip of the labium, and wing venation. Ventral plate hidden beneath the hairs of the posterior end of the abdomen, yellowish brown at tip, black toward base, much broader than long, terminating posteriorly in two finely pubescent lobes with a slight emargination between; anteriorly it is densely clothed with gray hair; ovipositor moderately long, almost straight.

Length of body, 0.95 mm; width of head, 0.29; length of wing, 1.03; width of wing, 0.41; length of antennæ, 0.57.

KANSAS, Lawrence, 4 males and 1 female; these are pinned specimens that are classified as *Ps. phalænoides* in the United States National Museum; the name of the collecter is not shown. MARYLAND, College Park, September 5, 1935, 1 female (*F. C. Bishopp's* light trap).

This is a small species easily recognized by the tip of the antennæ and the sensory spines. *Psychoda pusilla,* originally described from upper Austria, is here first reported in this country. Although I have not examined Tonnoir's specimens of *pusilla,* his figures of the species agree in all details with the specimens before me.

PSYCHODA GRISESCENS Tonnoir. Plate 2, figs. 6 to 11.

Psychoda grisescens TONNOIR, Ann. Soc. Ent. Belg. 62 (1922) 87–88.

Male.—Head, proboscis, and antennæ dirty grayish brown. Eyes narrowly separated at frons by a distance equal to about three-fifths the diameter of one facet. Frons and clypeus almost semicircular, surface covered with yellowish gray hairs. Proboscis short, about one-fourth the width of the head. Tip of the labium with three long teeth and one short tooth, the short tooth a little over half the length of the longest teeth; surface covered with microtrichia; two subequal spines very prominent on each side of the tip. Palpi dull brown, distal half clothed with grayish white hairs; first segment slightly enlarged basally, a little longer than the second or third segment; terminal segment longer than any of the other three segments. Antennæ of sixteen segments, a little longer than the width of the wing; basal segment cylindrical, slightly longer than broad; segment 2 globular; segment 3 smaller than 2, flask-shaped, diameter of the node four times that of the internode; segments 4 to 12

like 3, gradually diminishing in size; the segments clothed with scattered gray hairs; 13 globular with a very short neck; 14 and 15 very intimately connected, the former much wider than long, slightly larger than the latter, which has the same shape; 16 ovoid, distinctly separated from 15 by a short neck. The sensory spines on segments 3 to 12 are of the usual type with two anterior and one posterior branch; the branches, however, are strongly curved into an S-shape at their basal third.

Thorax yellowish brown, in front densely clothed with short, slender, gray hairs; behind, at base of wings, the hairs long, lighter, almost white. Wings narrower than in *pusilla* but not acutely angular at tip; above, veins evenly clothed with gray hair, similar to that of the body; below, base of veins with a few, scattered, dark gray hairs, followed by slender hairs of the same color, which extend to the tip of the wing; anterior fringe smoky, darker toward base; posterior fringe lighter, having a yellowish cast. Sc broad, almost twice as long as the semichitinous pad above it. Origin of $R_2 + R_3$ distinctly before r-m. Fork of R_2R_3 about the middle of the wing but before the extremity of $Cu_2 + 2d$ A. Fork of M_1M_2 weakly chitinized, much closer to fork of R_2R_3 than to r-m. Vein R_5 not well developed and heavily chitinized as in *pusilla*. Knob of halteres yellowish white with fine, short, grayish hairs; stem club-shaped with several slender whitish hairs. Legs dull brown, clothed with gray hairs; a number of long, dark gray hairs scattered over the tibiæ; tarsi with grayish white, scalelike hairs.

Abdomen brown, venter of first segment and anterior incisures broadly pale brown; dorsal surface of tergum towards base darker than the remaining parts; hairs on abdominal segments uniformly grayish white. Hypopygium pale brown, densely covered with grayish white hairs. Ninth tergite longer than broad. Anal flap at caudal end very similar to that of *pusilla*. Inferior appendages swollen basally, gradually tapering towards the tip, about one and one-half times as long as the length of the ninth tergite. Terminal spinule small, a little over one-fourth the length of the inferior appendages. First segment of superior appendages cylindrical, slightly swollen on its outer side; second segment much longer than the first, curved into a sharp pointed end. Ædeagus very similar to *pusilla;* composed of two parts; one long process, cylindrical, with rounded apex; the other a sharp process very much shorter and coiled around the first.

Length of body, 1.41 mm; width of head, 0.32; length of wing, 1.36; width of wing, 0.61; length of antennæ, 0.88.

Female.—Very similar to the male. Eyes at frons closer than in the male. Palpi at their distal half clothed with almost white hairs. Antennæ somewhat darker at the basal half; the whorls of hairs are much denser than in the male. Thorax appears more yellowish and the hairs on the dorsum are more thickly set; a few scattered yellowish hairs on the pleuræ. Abdomen darker than that of the male; tips of hairs on posterior segments nearly white. Ventral plate longer than broad, slightly constricted in the middle; distal end cleft so as to have a bilobed appearance. Ovipositor not twice as long as plate, darker than the plate, curved downward.

Length of body, 1.50 mm; width of head, 0.36; length of wing, 1.40; width of wing, 0.69; length of antennæ, 0.85.

JAMAICA, Kingston, 5 females and 2 males, received by the author from Dr. F. M. Root, January 5, 1934; specimens deposited in the United States National Museum.

PSYCHODA INTERDICTA Dyar. Plate 2, figs. 12 to 16.

Psychoda interdicta DYAR, Proc. Ent. Soc. Wash. 30 (1926) 87–89.

Male.—Occiput dull brown, widened medially, covered with erect grayish white hairs; anterior margin with a single row of long hairs. Eyes at frons separated by a distance equal to half the diameter of one facet. Frontal triangle dull brown, semicircular in outline, thickly covered with bushlike, erect, grayish white hairs. Clypeus brown, slightly convex medially, much wider than long, whole surface with erect grayish white hairs; outer margin close to the eyes provided with five long spinelike hairs. Proboscis pale brown, about as long as second palpal segment. Paraglossæ of medium size, provided with four short teeth near the apex; membranous area with from five to seven long spines. Theca heavily chitinized. Palpi and antennæ of the same coloration as clypeus; segments of the palpi are in the proportion of 5:8:9:10. Antenna of sixteen segments, with whorls of gray hairs lying closely to the segments, thus giving it a solid appearance; basal segment rather tubular, slightly widened anteriorly; segment 2 somewhat spherical; segment 3 club-shaped, node slightly longer than its internode; segments 4 to 12 almost flask-shaped; segment 13 with a very small neck; segments 14 and 15 of about the same size, separated from each other by a small neck; segment 16 ovoid, bearing a

short stout spine at its apex and several slender spines around it. Sensory spines on segments 3 to 13 of three branches; two long anterior branches slightly curved basally, reaching almost to half of the following node; a slender posterior branch extending a little over the length of its node.

Dorsum of the thorax dull brown to bronze; surface covered with long whitish hairs with grayish tips. Scutellum somewhat pale brown but with some coating of hairs on dorsum of the thorax. Pleuræ pale yellowish brown. Wings a little over twice as long as broad, slightly angulated at apex. Vestiture of wings smoky. Anterior fringe dark gray, darker towards the base. Posterior fringe lighter except for a thick smoky patch near the base. Sc short, origin of $R_2 + R_3$ distinctly before the level of r-m. Fork R_2R_3 at the middle of the wing. Fork M_1M_2 before the middle of the wing, about as close to r-m as it is to fork R_2R_3. Cell C + Sc darker than the rest of the cells in the wing. Halteres yellowish. All coxæ and trochanters pale brown; femora and tibiæ darker with dark gray hairs on anterior surface, appearing bluish in certain reflected lights; posterior surface with short and much lighter hairs. Anterior surfaces of tarsal segments with dark gray hairs; in reflected light the scalelike hairs appear whitish from above.

Abdomen brown dorsally; sides bronzed; venter and hypopygium pale brown; covering of hairs dark gray, heavy towards the posterior end. Ninth tergite slightly longer than broad, caudal flap very hairy. Inferior appendages slightly swollen basally, curved inwardly; terminal spinule long, about two-thirds the length of the inferior appendages. Basal segment of superior appendages somewhat triangular; distal segment cylindrical, widened basally, apex bluntly rounded, with a single long hair, whole surface of the segment covered with long slender hairs. Ædeagus composed of a single long process, its margin somewhat folded. Length of the ædeagus about one and one-half times that of the superior appendages.

Length of body, 1.90 mm; width of head, 0.38; length of wing, 1.82; width of wing, 1.96; length of antennæ, 1.27.

Female.—Covering of hairs decidedly darker than in the male. Eyes at frons separated by a distance equal to one and one-half times the diameter of one facet. Semichitinous pad well developed and heavily chitinized. Tip of vein M_1 with a slight indication of a blackish spot. Cell C + Sc highly pigmented. Abdomen darker than in the male. Ventral plate gently emar-

ginate; basally with a pair of small lobes. Ovipositor short and somewhat curved.

Length of body, 2.00 mm; width of head, 0.38; length of wing, 1.96; width of wing, 1.23; length of antennæ, 0.81.

NEW YORK, Ithaca, September 5, 1916, 7 specimens of both sexes, types, *40516 U. S. Nat. Mus.*, from Cornell University collection. MARYLAND, College Park, August 13, 17, 26, 1933 (*F. C. Bishopp's* light trap), September 5, 15, 19, 1933 (*F. C. Bishopp's* light trap); Solomon Island, August 19, 1933 (*F. C. Bishopp's* light trap); Baltimore, Roland Park, June 1 to 7, 1934 (*F. M. Root*); Annapolis, St. John College, August 12 and 16, 1933 (*F. C. Bishopp's* light trap); Indian Head, August 16, 1933 (*F. C. Bishopp's* light trap); Berlin, August 17, 1933 (*F. C. Bishopp's* light trap); Salisbury, September 25, 1933 (*F. C. Bishopp's* light trap). WEST INDIES, Santa Lucia, Gastries, September 10 to 22, 1919 (*J. C. Bradley*).

The description of *Ps. uniformata* as given by Haseman might apply to this species, although in his description of the antenna Haseman mentioned that it was of fifteen segments with a terminal spike.

PSYCHODA MARYLANDANA sp. nov. Plate 2, figs. 17 to 21.

Male.—Head from above appearing nearly rounded; occiput, frons, and clypeus brown; hairs covering them yellowish gray; occiput narrow. Eyes at frons separated by a distance equal to more than one-fifth longer than the diameter of one facet. Frontal triangle kidney-shaped, brown, covered with thick-set hairs on its basal half. Antennal fossæ prominent. Clypeus about as long as broad, slightly convex on its anterior margin; at its apex terminated by a narrow castaneous margin. Proboscis dark brown, with grayish white hairs, slightly longer than the first palpal segment. Tip of the labium with three long teeth and one short tooth, the latter about one-half as long as the former; outer margin with two spines subequal in length, the whole surface covered with microtrichia and fine slender hairs. Palpi pale brown with grayish white hairs; first three basal segments of about equal length; the terminal segment about one and one-half times as long as the third; second and third slightly widened. Antennæ of sixteen segments, dark brown, with grayish white hairs. Basal segment short, slightly swollen on one side, slightly longer than 2, which is globular. Segments 3 to 12 of about the same size and shape as in *pusilla* or *uniformis*. Tip of the antennæ similar in construction to *trinodulosa* Tonnoir. Sensory spines of three branches, two

anterior branches nearly touching the base of the node of the following segment and a short, rather weak, slightly pointed, usually straight, posterior branch.

Dorsum of the thorax blackish, covered with erect, yellowish gray hairs, more thickly set towards the scutellum. Pleuræ dull brown, with a few short, scattered, whitish hairs. Wings lanceolate uniformly yellowish gray, whitish gray in some reflected lights. Anterior and posterior fringes appear darker due to their thick pile. A bunch of erect gray hairs at the base of the wing on the undersurface. Sc slightly longer than the semichitinous pad above it. Origin of $R_2 + R_3$ a little after the level of r-m. Fork R_2R_3 a little before the middle of the wing, much closer to fork M_1M_2 than to r-m. Fork M_1M_2 weakly chitinized, much closer to r-m than to fork R_2R_3. Knob of halteres whitish; stem yellowish gray. Legs pale brown; anterior and posterior margins of mid- and hind femora, apical half of their tibiæ, and all tarsal segments darker. Hairs on femora and tibiæ short, appearing yellowish gray.

Tergites of abdomen blackish; incisures pale brown; pleural membrane and basal two-thirds of the venter brown; hairs yellowish white, somewhat longer on the anterior surface of two basal segments, with a few long, almost white, hairs. Ninth tergite somewhat semicircular at its distal end, basally narrowing into a broad neck. Inferior appendage swollen near the base, slightly curved, tapering gradually, its apex bearing a single spinule. Basal segment of superior appendages not well developed, slightly curved medially; distal segment somewhat enlarged at the middle, distal half tapering into a clawlike point, near the apex it is provided with two long and three or four short spines. Ædeagus composed of a spatulate structure rounded at tip and a small pointed piece with a pair of triangular processes immediately beneath, the upper ends of the plates somewhat bent on one side.

Length of body 1.00 mm; width of head, 0.29; length of wing, 0.96; width of wing, 0.40; length of antennæ, 0.91.

Female.—Very similar to the male. Tip of the labium with teeth not as long as in the male. Proboscis longer than in the male. Ventral plate blackish, lobes conical, distance between the apex of the lobes twice the depth of the emargination; medially a tubular structure appearing attached to a heavily chitinized plate. Ovipositor black, slightly curved, strongly chitinized basally.

Length of body, 1.2 mm; width of head, 0.25; length of wing, 1.00; width of wing, 0.45; length of antennæ, 0.61.

MARYLAND, College Park, September 5, 1933, and August 26, 1935, 13 females and 1 male (*F. C. Bishopp's* light trap). The type material will be deposited in the United States National Museum.

This is a small species occurring with *phalænoides, cinerea,* and *uniformis.* In general appearance a dry specimen is very similar to *pusilla* and *uniformis.* Resembles the European *trinodulosa* in the form of the tip of the antenna and wing venation, although it is otherwise very different.

PSYCHODA UNIFORMIS sp. nov. Plate 2, figs. 22 to 25.

Female.—Occiput, frons, and clypeus brown, uniformly covered with grayish white hairs. Distance between the eyes at frons three-tenths in excess of the diameter of one facet. Frontal triangle rather heart-shaped, wider than long; clypeus slightly wider than long. Proboscis slender, about as long as the last palpal segment, with short almost appressed grayish white hairs. Palpi pale brown covered with yellowish gray hairs; the three basal segments about equal in length; the last segment slightly longer than the third, slightly pointed apically. Tip of labium with four long teeth and one short tooth, the shortest teeth nearly two-thirds as long as the longest, with more or less rounded tips; two spines on the membranous surface of the tip. Microtrichia rather scanty near the attachment of the teeth. Antennæ dark brown with whorls of grayish white hairs; fifteen segments; segment 1 slightly longer than broad; 2 spherical, broader than long; 3 to 12 flask-shaped, size of the node gradually diminishing towards the tip; node of segment 13 like the nodes of the middle segments with just an indication of a broad neck, 14 much smaller than 13, globular; 15 ovoid, smaller than 14. Sensory spines on segments 3 to 13 consist of two anterior branches reaching as far as the joint of the following segments.

Anterior dorsum of thorax brown, uniformly covered with grayish white hairs; the sides in front and the pleuræ pale brown; scutellum dark brown. Wings rather ovate, slightly pointed at apex. Wing fringe grayish white. Hairs on the veins of the usual type. Sc short, about as long as the semichitinous pad above it. Fork $R_2 + R_3$ after the middle of the wing, very weakly chitinized. Fork M_1M_2 also weakly chiti-

nized, distinctly before the middle of the wing. Halteres small; knobs grayish white. Legs brown; femora scantily covered with grayish white hairs; tibiæ and last tarsal segment slightly darker, covering of hairs more grayish.

Abdomen castaneous to blackish; the lateral margins, fifth segment, and apices of the segments shining, whole surface covered with grayish white hairs. Sides of first segment broadly dull black. Second segment with a broad, median, blackish area on the dorsum. Venter brown. Ventral plate much broader than long, with shallow emargination apically; the lobes produced, rather conical. Ovipositor bladelike, slightly concealed, length about three times the distance between the tips of the lobes.

Length of body, 1.30 mm; width of head, 0.26; length of wing, 1.16; width of wing, 0.47; length of antennæ, 0.33.

MARYLAND, College Park, August 26 and September 5, 1933, 15 specimens (*F. C. Bishopp's* light trap). The type material will be deposited in the United States National Museum.

This is one of the smallest species in the North American fauna and may possibly be either *Ps. minuta* Banks or *Ps. uniformata* Haseman. Since *minuta* and *uniformata* have evidently not been recorded since their description, the evidence as to the identity of this species is suggestive though not final, and if it should prove to be the same as *minuta* or *uniformata,* the form to which the name is here assigned would become *Ps. minuta* or *Ps. uniformata.* However, until Bank's type or Haseman's type (neither of which, in all probability, exists) can be studied carefully, it will not be possible to determine definitely the status of this species.

PSYCHODA SIGMA Kincaid. Plate 3, figs. 1 to 4.

Psychoda sigma KINCAID, Entom. News **10** (1901) 31.

Psychoda surcoufi TONNOIR, Ann. Soc. Ent. Belg. **62** (1922) 74–76.

Female.—Occiput, frons, and clypeus light brown; occiput with whitish hair and a few yellowish hairs. Distance between the eyes at frons about equal to the diameter of two facets. Frontal triangle pronounced, with yellowish hairs arranged about the middle region between the antennal fossæ. Clypeus slightly wider than long. Proboscis short, nearly as long as the first palpal segment, with short, appressed, whitish hair. Palpi pale brown, covered with yellowish hairs; ratio of palpal segments: 18 : 22 : 23 : 30. Tip of the labium with four long teeth and one short tooth; the shortest about two-thirds as long as the longest.

Outer surface of the tip with two spines and microtrichia that are rather indistinct near the base of the teeth. Antennæ of fourteen segments, pale brown, with verticils of yellowish hairs; segment 1 subcylindrical, slightly longer than wide; 2 globular; segments 3 to 12 flask-shaped, nodes globular, diminishing in size towards the tip; internodes of each segment slightly longer than the diameter of the node; segment 13 somewhat globular; 14 ovoid; segments 13 and 14 separated by a short neck, which is hardly swollen but bears two short spines. (Tonnoir considers this as a true segment, but I cannot agree with him as there is no clear line of demarcation to delimit it as a true segment.) Sensory spines like those of *phalænoides*, with two anterior branches and one posterior branch.

Mesonotum pale brown, with cream-colored hairs arranged in three rows; pleuræ pale yellow. Wings over twice as long as broad, slightly angulated at tip. Anterior and posterior fringes dense and yellowish except for two patches of smoky hair at the anterior and posterior ending of the irregular band which is shaped like an inverted V with the pointed end directed towards the tip of the wing. Sc short. Origin of $R_2 + R_3$ on the same level with r-m. Fork M_1M_2 closer to fork R_2R_3 than to r-m, origin of the stem before r-m. Halteres small, knob with grayish white hairs. Legs pale yellow with yellowish hairs.

Abdomen pale brown with yellowish white hairs, the lateral margins somewhat darker but also covered with yellowish white hairs. Venter brown, covering of hairs grayish. Ventral plate narrow near its base but gradually widening posteriorly into equal lobes, which are separated by a deep emargination. Ovipositor brown, long, pointed, and slightly curved.

Length of body, 1.01 mm; width of head, 0.45; length of wing, 1.87; width of wing, 1.05; length of antennæ, 1.05.

I have not examined the male; the original description is as follows:

Male: Smaller than female, with the black band upon the wings less clearly evident. Genitalia conspicuous, brown, clothed with long cream-colored hair. Inferior appendages 3-jointed; joint 1 (ninth tergite) stout, cylindrical; joint 2 twice as long as 1, slender, slightly swollen at base, curving upwards; joint 3 very slender, cylindrical, tapering at apex. Superior appendages not as long as the basal joint of inferior; 2-jointed; joint 1 stout; joint 2 tapering to an acute point.

Type locality, Olympia, Washington, June 24 to July 1, 1897.

I have studied one female determined by Kincaid, from Seattle, Washington, January 6, 1900.

There can be no doubt that *sigma* is the valid name and that *surcoufi* is a synonym of it. The description and figures of *surcoufi* as given by Tonnoir agree very closely with my figures of *sigma*.

PSYCHODA BICOLOR Banks. Plate 3, figs. 5 to 10.

Psychoda bicolor BANKS, Can. Ent. **26** (1894) 333.

Psychoda nigra (Banks) DYAR, Proc. Ent. Soc. Wash. **30** (1928) 87-89.

Male.—Occiput, frons, clypeus, and the two basal antennal segments yellowish white, covered with erect white hairs. Occiput broad. Eyes at frons well separated by a distance equal to a little more than the diameter of three facets. Frontal triangle large, much wider than long, gently convex. Clypeus much wider than long, shallowly emarginate, receding below medially, the oral margin slightly produced. Proboscis yellowish brown with short yellowish hairs, about three-fourths the length of the first palpal segment. Palpi slender, pale brown, with short dark gray hair, about one-third the length of the antennæ. First palpal segment short, second segment about twice the length of the first, the third rather stout, a little over the length of the second and about as long as the fourth segment. Paraglossæ much like those of *autumnalis* Banks, with seven, pointed, spinelike teeth on each side at the proximal margin. Spines on the outer margin close to the tip more numerous and well developed. Antennal segments bronzed except for two yellowish white basal segments; segments 3 and 4 covered with yellowish gray hairs, remaining segments with dark gray hairs. Basal segment of antennæ about as broad as long; segment 2 spherical, strongly united to the first; segment 3 long, greatest diameter at about one-half of the segment, node gradually narrowing basally, about twice the length of the internode, its greatest diameter about three times the diameter of the internode and about three-sevenths the length of node. Segment 4 club-shaped, node slightly longer than the internode, diameter of the node about one-half its length and about three times the diameter of the internode. Nodes of segments 5 to 12 gradually increasing in diameter with a corresponding decrease in length, the internodes progressively increasing in length; internodes of segment 12 about one-third the length of the node; segments 14 and 15 about one-third the size of segment 12, distinctly separated from each other by a short internode. Last segment lemon-shaped, of same size as segment 14

or 15, separated from 15 by a short internode. Sensory spines, one on each side of segments 3 to 13, composed of two branches—a long anterior branch, which is bladelike, broad at base and gradually tapering, slightly curved at its basal third; a short, slender, posterior branch about one-half the length of the anterior branch.

Mesonotum yellowish brown, anterior margin lighter; lateral margins and all of the pleura yellowish white; scutellum yellowish brown. Hairs on the thorax white with a few, scattered, grayish white hairs. Knob of halteres grayish white, stem whitish; covering of hairs dark gray, with a little over twice as long as broad, acutely pointed at apex. Anterior fringe evenly dark gray or blackish; posterior fringe of same color as anterior fringe, but the hairs are much longer. Hairs on wing veins uniformly dark gray or blackish. On the undersurface, at about basal one-half, the veins are covered with short, blackish, scalelike hairs. Sc about two and one-half times the length of the semichitinous pad. Origin of $R_2 + R_3$ before the level of r-m. Fork R_2R_3 a little beyond the middle of the wing. Fork M_1M_2 weakly chitinized, much closer to r-m than to fork R_2R_3. Legs pale brown, with dark gray hairs; coxæ and trochanters yellowish white with several grayish hairs. Tibiæ of the forelegs covered with long blackish hairs; first tarsal segment clothed with short gray hairs; hairs on the remaining tarsal segments short, appressed, scalelike, grayish white. Mid- and hind femora with uniform dark gray hair; tibiæ with many long and slender yellowish hairs, hairs on the tarsal segments appear grayish white in certain reflected lights.

First three abdominal segments wholly pale brown, the median portion blackish with dark gray hairs. Fourth and remaining abdominal segments dark grayish brown with dark yellowish gray hair. Hypopygium pale brown with a dense covering of white hair. Ninth tergite about as long as broad, slightly wider at base. Inferior appendages slightly swollen at base, gradually tapering toward the apex, about as long as the ninth tergite, the whole surface covered with numerous straight spines; apex bearing three terminal spinules; middle spinule slightly longer than the two others and about one-half the length of the inferior appendages. Superior appendages of two segments; basal segments stout, heavily chitinized with abundant, fairly long, scalelike hairs on the outer surface; the inner surface on the apical fourth with a single long spine almost as long as the second

segment of the superior appendages; second segment of superior appendages slightly curved, over twice as long as the basal segment, slightly enlarged basally, becoming slender toward the apex. Ædeagus strongly developed and heavily chitinized; composed of two, long, acutely pointed processes, one rather clawlike at tip, the other strongly curved almost to an S-shape with a very short, rather toothlike, blunt tip.

Length of body, 2.80 mm; width of head, 0.45; length of wing, 2.76; width of wing, 1.18; length of antennæ, 2.38.

Female.—Resembles the male. Eyes at frons more widely separated than those of the male. Paraglossæ more prominent. Tips of the antennæ similar to those of the male. Wings more acutely pointed at apex, with no blackish scalelike hairs on the basal half of the undersurface. Ventral plate very shallowly emarginate, the corresponding lobes wide; anterior margin rounded, their membranous tips provided with several long and short spines. In the region of the anus is an anal flap, rather tubular in form, bearing five long spines nearly equal in length, their apices almost reaching the margin of the plate.

Length of body, 2.95 mm; width of head, 0.50; length of wing, 2.91; width of wing, 1.23; length of antennæ, 2.00.

NEW YORK (*N. Banks*), type locality; McLean Reservoir, August 27, 1925 (no collector given), June 10, 1933 (*F. del Rosario*); Ithaca, June 1, 1933 (*F. del Rosario*). MARYLAND, College Park, August 14 and 19 and September 13, 1933 (*F. C. Bishopp's* light trap); Cabin John Bridge, May 16, 1909 (*F. Knab*); Plummer's Island, July 26, 1909 (*F. Knab*). DISTRICT OF COLUMBIA, Washington, May 22, 1914 (*F. Knab*). INDIANA, Lafayette, August, 1917 (*J. M. Aldrich*).

Dyar (1926), on the supposition that the specimens from New York, which Banks (1894) described as *bicolor,* represented the male of *nigra,* included the former as a synonym of the latter. This was wrong, as I have collected specimens of both sexes of both of these species, which prove to be entirely distinct. As stated above, the female of *bicolor* resembles the male very closely, differing only in coloration and in structural characters.

PSYCHODA NIGRA Banks. Plate 3, figs. 11 to 16.

Psychoda nigra BANKS, Can. Ent. 26 (1894) 331.
Psychoda marginalis BANKS, Can. Ent. 26 (1894) 333.
Psychoda apicalis BANKS, Proc. Ent. Soc. Wash. 8 (1906) 148–151.
Psychoda basalis BANKS, Proc. Ent. Soc. Wash. 8 (1906) 148–151.

Pericoma orillia CURRAN, Can. Ent. 56 (1924) 218.
Psychoda varitarsis CURRAN, Can. Ent. 56 (1924) 220.
Maruina nigra (Banks) DYAR, Insec. Inscit. Menst. 14 (1926) 111.
Pericoma apicalis (Banks) DYAR, Insec. Inscit. Menst. 14 (1926) 149.
Psychoda nigra (Banks) DYAR, Proc. Ent. Soc. Wash. 30 (1928) 87–89.

Male.—Head black, thickly covered with a brush of white hairs on the frons, clypeus, and occiput; the hairs on the occiput vary gradually to dark gray on the sides; two lobes resembling the breathing tubes of *Anopheles* pupæ project from behind the occiput, coloration like that of the occiput. Eyes at frons separated by a distance equal to the diameter of two facets. Frontal triangle reddish, much wider than long, lobes at the antennal fossæ acutely rounded at apex. Clypeus reddish, narrowed apically. Proboscis pale brown, slightly longer than the first palpal segment. Palpi blackish, densely covered with a tuft of short, bluish black, scalelike hairs, first palpal segment shortest, last three segments of about equal length, the third moderately swollen. Paraglossæ similar to those of *bicolor*, with five teeth on each side arranged in a single row; a somewhat irregular transverse row of twelve long spines along the sides of these teeth. Antenna dark brown to black, with dark gray verticils about twice as long as broad, with a brushlike covering of black hairs on its inner surface; segment 2 nearly globular, with a blackish tuft on its inner surface; segments 3 to 15 rather flask-shaped, the nodes nearly globular, internodes slightly shorter than the diameter of the node; sensory spines similar to those of *autumnalis* Banks; the branches, however, are finer and slender; segment 16 with a terminal spike or stylet.

Thorax dark brown; mesonotum darker, sides and anterior margin more or less brown; center of scutellum dark brown; pleuræ pale brown; hairs on dorsum of thorax dark gray, those on the sides blackish. Halteres dull though not dark brown; knob with short, appressed, blackish hairs; stem short. Wings over twice as long as broad, slightly bluntly rounded at tip and terminating close before the end of R_3. Basal half of anterior fringe dark gray, the distal half smoky; posterior fringe long, blackish basally and evenly smoky towards the apex. Hairs on the veins dark grayish brown except those at basal one-seventh which are grayish white. Hairs on the undersurface at basal one-half black, distinctly scalelike. Hairs on semi-chitinous pad grayish white. Sc long, a little over the length

of $R_2 + R_3$ from its point of origin to its fork. Origin of $R_2 + R_3$ at about one-third the length of the wing, much closer to r-m than to fork M_1M_2. Fork M_1M_2 close to the middle of the wing. Cells C + Sc and 1st A + Cu heavily chitinized, dotted with the roots of the blackish hairs. Coxæ and trochanter pale brown, with dark gray hairs on the outer surface. Femora of forelegs brown, covered with blackish hairs; posterior margin with a row of ten to twelve bristles. Fore tibiæ and tarsal segments brown, covered with black to dark gray hairs, the inner surfaces lighter. Mid- and hind tibiæ brown with both short and long black hairs; the long hairs appear gray or smoky when examined under diffused light; hairs on tarsal segments like those on the forelegs.

Abdomen dark brown; hind margins blackish medially; thickly set with dark gray and blackish hairs. Hypopygium dark brown, sparsely set with grayish white hairs. Ninth tergite about as long as broad; distal end with two subequal anal flaps. Inferior appendages stout, almost cylindrical, slightly swollen basally, gently curved with a group of about thirteen to sixteen spinules on the undersides close to the apex; at about the middle on the undersurface are two long slender spinules, a little over one-half the length of the inferior appendages. Basal segment of superior appendages short, stout, rather enlarged basally; distal segment slightly longer than the first, also slightly swollen at base, gradually tapering into a clawlike tip. Ædeagus made up of two long curved processes sharply pointed at tip. On the upper surface of the ninth tergite and intimately associated with the basal segment of the inferior appendages is a chitinized plate about as long as the basal segment of the inferior appendages, rather elliptical in shape, with a notch at the tip. It possibly is a part of the genital armature.

Length of body, 2.28 mm; width of head, 0.47; length of wing, 2.20; width of wing, 0.83; length of antennæ, 1.60.

Female.—Palpi lighter than those of the male; antennal segments not as large as in the male; nodes rather elliptical, with a whorl of long grayish hairs. The sensory spines like those of *autumnalis* Banks, with fingerlike branches, usually five. Undersurface of wings without black scalelike hairs. Wings narrower than those of the male; anterior and posterior fringes blackish. Femora of forelegs without bristles on their posterior margins. Hairs on the anterior margin of the tarsal segments of the legs not as black as in the male. Ventral plate not prominent, being concealed by the long black hairs of the venter

of the abdomen; shallowly emarginate, the notch hardly one-half as deep as the distance between the lobes. Ovipositor about twice as long as the width of the plate and a little curved.

Length of body, 2.41 mm; width of head, 0.50; length of wing, 2.29; width of wing, 1.03; length of antennæ, 1.01.

VIRGINIA, Falls Church, May 3 (*N. Banks*, type of *apicalis*), May 7, 1906 (*N. Banks*, type of *basalis*); Glencarlyn, May 9, 1909 (*F. Knab*). INDIANA, Lafayette, July 16, 1915 (*J. M. Aldrich*, a slide preparation made from this specimen by Dyar is labeled *Ps. basalis*). MARYLAND, Cabin John Bridge, May 16 and August 22, 1909 (*F. Knab*); College Park, August 26, 1933 (*F. C. Bishopp's* light trap); Snowhill, August 26, 1933 (*F. C. Bishopp's* light trap); Plummer's Island, May 10, 1905 (*Barber and Schwartz*). NEW YORK, Ithaca, June 1, 1933 (*F. del Rosario*); Long Island (*N. Banks*, types of *Ps. marginalis*). QUEBEC, Megantic, June 18, 1923 (*C. H. Curran*, paratype of *Pericoma varitarsis*). ONTARIO, Orilia, June 26, 1926 (*C. H. Curran*, specimen is determined as *Ps. orillia* by Curran). MAINE, Orono, June (*Cornell University collection*). NEW HAMPSHIRE, Franconia (*A. T. Slosson*). NEW JERSEY, National Park, May 6, 1909 (no collector). OHIO, Cuyuga Falls (*W. V. Warner*).

This species has been described by Banks under four different names since 1894, and Dyar in 1926 placed it under the genus *Maruina*. However, in a recent paper (1928) Dyar reaffirmed his determination making *Maruina nigra* (Banks) a synonym of *Ps. nigra* Banks. In the same paper Dyar included *Ps. apicalis* Banks, *Pericoma apicalis* (Banks) Dyar, *Ps. orillia* Curran, and *Ps. varitarsis* Curran as synonyms of *Ps. nigra* Banks. Upon working over the material in the United States National Museum, which includes the types and paratypes, I find that *marginalis* and its synonyms as given by Dyar are true *nigra* Banks. A careful study of the type of *basalis* Banks shows that it also is *nigra*. The evidence as to the identity of the *nigra* of Banks is based upon the comparison of the tip of the antenna, wing venation, and structural characters of the male hypopygium with the different synonyms given above.

PSYCHODA OPPOSITA Banks. Plate 4, figs. 1 to 5.

Psychoda opposita BANKS, Can. Ent. 33 (1901) 274.

Male.—Occiput wholly brown, with pale gray hairs on the sides and a group of white hairs on the posterior margin; on the anterior margin, close to the side of the eyes, is a row of about

eight to ten long hairs. Frontal triangle brown, with dark gray hairs confined to the center of the triangle. Eyes at frons almost confluent, facets near frons arranged in four rows. Clypeus much wider than long, dark brown, clothed with long, dark gray hairs; on each side close to the posterior margin of the eye is a row of five strong hairs. Proboscis about as long as the first palpal segment, brown, with short dark gray hairs. Paraglossæ bulblike in shape; posterior arm of theca longer than the two anterior arms, well chitinized; furca heavily chitinized; inner surface of paraglossæ on each lobe with three strongly developed teeth more or less spinelike; outer surface with four long spines. Palpi with short, appressed, grayish hairs; palpal segments of about equal length. Antennæ pale brown, with grayish hairs; towards the basal segments the hairs are darker. Verticils on the nodes slightly compressed and lying parallel to the length of the segments. First basal segment very slightly longer than broad and about as long as segment 2, which is globular; nodes of segments 3 to 6 longer than their internodes, globular; sensory spines on each segment consist of three branches, two long anterior branches and a shorter branch. (The number of segments and the structure of the tip could not be made out as the tips apparently have been broken in the pinned specimen.)

Mesonotum brown, with white hairs; pleuræ brown, apparently bare. Wings lanceolate, acute at tip, clothed with pale grayish white hairs. Anterior fringe almost white; posterior fringe longer than the anterior, the hair on the former mostly pale grayish white. Three distinct dark areas on the wings distributed as follows: A broad, irregular, black area of erect black hairs near the base; a small black spot formed also of erect black hairs near the end of vein R_2 and another black spot similar to that on R_2 near the end of M_3 just above the tip of Cu_1. The two small black spots are exactly opposite each other with a rather indistinct dark fascia joining them. The extreme tips of R_5 and M_2 with indications of black spots. The hairs on the veins are mostly pale grayish white. Knob of halteres pale yellow with whitish hairs. All legs pale brown, uniformly clothed with dark gray hairs, except the anterior margin of each tibia, which is brownish.

Abdomen dark brown, clothed with dark gray hairs. Venter lighter and covered with short whitish hairs. Ninth tergite about as long as broad, moderately swollen near the middle region; toward the caudal region is a circular area distinctly

with microtrichia. Basal segment of inferior appendage longer than broad, slightly enlarged about the middle portion; distal segment clawlike, longer than the basal, tip with two short hairlike spines. Superior appendages rather tubular, except near the apex where they begin to taper and bear two clavate spinules; the spinules about two-thirds as long as the basal appendage; whole surface of the inferior appendages covered with straight hairlike spines. Ædeagus consists of a long tubular piece reaching almost to the tip of the superior appendages and a basal plate with two, sharp-pointed, toothlike projections.

Length of body, 1.73 mm; width of head, 0.38; length of wing, 1.53; width of wing, 0.54; length of antennæ (six basal segments), 0.47.

Female.—In coloring resembling the male but with the integument of the mesonotum nearly black. Abdominal tergites with brown transverse fasciæ which do not reach the incisures. Ventral plate nearly as broad as long; posterior lobes distinctly separated by a deep notch; outer surface of the lobes with long bristles. Ovipositor about two and one-half times the width of the ventral plate, distinctly curved and pointed.

Length of body, 1.92 mm; width of head, 0.40; length of wing, 1.63; width of wing, 0.58; length of antennæ, 0.38.

DISTRICT OF COLUMBIA, Washington, August 17 (*H. Barber*). MARYLAND, Plummer's Island, January 25, 1907 (*W. V. Warren*, determined as *Ps. opposita* by N. Banks).

PSYCHODA SUPERBA Banks. Plate 4, figs. 6 to 11.

Psychoda superba BANKS, Can. Ent. 26 (1894) 332.

Male.—Occiput, frontal triangle, and clypeus black; occiput with white hairs. Eyes at frons separated by a distance equal to about the diameter of one facet. Frontal triangle widening towards the clypeus, covered with black hairs. Clypeus slightly convex, broader than long, lateral margin with a row of four stout hairs. Proboscis a little longer than the first palpal segment, clothed with short blackish hairs. Paraglossæ with four short teeth on each side of the lobe and about seven long stout spines on the outer surface. Furca heavily chitinized. Posterior stem of theca shorter than the anterior arms. Palpi black; palpal segments in the proportion of 5 : 12 : 9 : 8. Antennæ of sixteen segments; node of each segment black, with blackish hairs; verticils of hairs on the nodes somewhat compressed; segment 1 cylindrical, slightly longer than broad; 2

subglobular; node of segments 3 to 15 slightly globular, diameter of each node equal to about the length of its internode; segment 16 with a spike, which is covered with microtrichia, and close to the base of the spike are eight fingerlike projections, their length equal to that of the spike. All the segments of the antennæ except the two basal segments are provided with elongated, S-shaped, sensory spines; each node having two spines, their origins very closely approximated to each other.

Thorax black, shining; mesonotum and upper portion of pleuræ with snow-white hairs; posterior portion of mesonotum with black hairs. In some specimens all the mesonotum is covered with white hairs. Wings ovate, slightly angulated at tip. Anterior and posterior fringes nearly black, whitish near the tip of the wing. Tips of all veins with small black patches of hair and white patches between them. Before the black patch at the tip of each vein is a small white patch. A band of erect white hairs at the base of the wing. Bases of veins R_1, R_4, R_5, $M_1 + M_2$, and $Cu_2 + 2d\ A$ with white hairs. Patches of white hairs are also found on costa just above tip of Sc and at about the middle of vein R_1. At about two-thirds of veins R_2, R_3, and R_4, middle of R_5, and at two-thirds of M_1 and M_3 some white hairs are also present. Sc long, about one-half the length of R_1. Origin of $R_2 + R_3$ before the middle of the wing and a little behind the level of the end of $Cu_2 + 2d\ A$ but before the level of r-m. Fork $M_1 + M_2$ slightly before the level of fork R_2R_3, nearer to fork R_2R_3 than to r-m. Halteres small, black, knob with dark grayish hairs; stem slender, with yellowish hairs. Legs black with black hairs; tips of tibiæ and first and second tarsal segments with white rings.

Abdomen dark gray with dark grayish hairs. Incisures whitish, also covered with dark grayish hairs. Venter pale brown with decidedly gray hairs. Hypopygium with long dark gray hairs and a few scattered black hairs. Ninth tergite much broader than long, with a single spiracular opening. Anal flap nearly one-third the length of the inferior appendages, evenly rounded at the tip. Inferior appendages rather cylindrical and slightly curved, surface wholly covered with straight hairlike spines; apex bearing from twelve to fourteen short spinules. Basal segment of superior appendages well developed; distal segment slender, longer than the basal segment. Ædeagus consists of a posterior tubular arm, apparently flattened, and a shorter, anterior, slender, rodlike piece inclosed in a heavily chitinized sheath.

Length of body, 2.21 mm; width of head, 0.47; length of wing, 1.92; width of wing, 0.85; length of antennæ, 1.40.

Female.—Similar to the male in markings. Antennæ shorter than in the male, with nodes somewhat elongated; verticils of hairs not so dense as in male and tend to spread outward. Sensory spines simple, not elongated S-shaped, but projecting toward the internode. Ventral plate broad, emargination about as long as wide; lobes becoming pointed at their tips. Ovipositor about twice the width of the ventral plate.

Length of body, 2.54 mm; width of head, 0.49; length of wing, 2.00; width of wing, 0.96; length of antennæ, 0.95.

MARYLAND, Solomon Island, August 5, 1933 (*F. C. Bishopp's* light trap); College Park, August 5 and 26, 1933 (*F. C. Bishopp's* light trap). DISTRICT OF COLUMBIA, Washington, August 17 and 18 (*H. Barber*). VIRGINIA, Tapahamok, June 6, 1934 (*F. M. Prince*). NEW YORK, Sea Cliff (*N. Banks*, specimens determined as *Ps. superba* by Banks).

PSYCHODA SUPERBA Banks var. CONSPICUA var. nov. Plate 4, figs. 12 to 14.

From the typical form described in 1894 by Banks, this form differs as follows: Male antennæ with sensory spines very conspicuously shaped like a horn with two arms curved toward the node of the segment. The two spines are diametrically opposed on each segment of the antennæ. Vein Sc about one-third the length of R_1. Forks R_2R_3 and M_1M_2 in line with the ending of $Cu_2 + 2d$ A. Male genitalia with two spiracular openings on the ninth tergite. Inferior appendages each with nine to ten spinules at its apex.

The female is very similar to the female of the typical form in the structure of the tip of the antennæ, in the wing venation, and in the ventral plate.

Male.—Length of body, 2.23 mm; width of head, 0.51; length of wing, 2.00; width of wing, 0.94; length of antennæ, 1.31.

MARYLAND, Solomon Island, August 5 and 9, 1933; Annapolis, St. John College, August 12, 1933; College Park, August 14, 15, 17, and 20, 1933; Indian Head, August 20, 1933 (all specimens from Maryland are from *F. C. Bishopp's* light trap). VIRGINIA, Oxomore, August 20, 1933 (*F. C. Bishopp's* light trap).

PSYCHODA AUTUMNALIS Banks. Plate 4, figs. 15 to 20.

Psychoda autumnalis BANKS, Ent. News 25 (1914) 127–128.
Pericoma littoralis DYAR, Insec. Inscit. Menst. 14 (1926) 107–110.
Pericoma aldrichana DYAR, Insec. Inscit. Menst. 14 (1926) 107–110.

Male.—Head and thorax bronze, rather dull. Occiput broad with a median depression, the diverging sides gently convex, with yellowish white hairs. (In several specimens the yellowish white hairs have gray tips.) Eyes separated by a fine line. Frontal triangle much wider than long, with widely diverging sides on the upper thirds, of the same coloration as occiput, with a brush of thickly set grayish white to smoky hairs. Clypeus slightly longer than broad, thickly set with hairs like those of the frons. Proboscis short, with black pile near tip. Paraglossæ bulblike, membranous, slightly flexible with no constriction at the proximal margin, with six short teeth (three on each side) on the proximal portion and a group of long and short spines on the membranous area close to the tip. Theca distinctly heavily chitinized, Y-shaped; the cordlike stem of the Y forms a median line and the two arms diverge anteriorly. Furca weakly chitinized. Palpi and antennæ of same coloration as the head; segments of the palpi in the proportion of 25 : 35 : 34 : 40. Antennæ of sixteen segments, with dense whorls of dark gray hair, except that on segment 8 which is yellowish white or almost white; segment 1 large, becoming enlarged distally; segment 2 globular; segment 3 cup-shaped with short internodes, sensory spines finger-shaped, continuous around the node; remaining segments like segment 3 in structure and shape but gradually diminishing in size. Segment 16 with a long terminal spike, which is about as long as the width of the node, and a very short one, which is about one-fourth the length of the long one; both spikes bear short fine spines; anterior portion of the node bears several toothlike projections with minute spines.

Mesonotum uniformly bronzed except on the notopleuræ; dorsum with indications of two nearly parallel stripes crossing the length of the mesonotum (visible only with sufficiently high power); surface covered with long white hairs with grayish tips; medially they do not seem to be arranged in rows. Scutellum of same color as mesonotum, with long, erect, grayish white hair. Pleuræ dull brown. Hairs above halteres almost white. Knob of halteres dark with dark gray hairs; stem yellowish with yellowish white pruinescence. Wings a little over twice as long as broad, bluntly rounded at apex and terminating close behind the ending of R_4. Vestiture of wings dark gray with white spots giving a mottled appearance. White spots arranged about as follows: A large and a small spot on the anterior fringe at basal one-fifth and basal one-half of the wing,

respectively; small spots at tips of veins R_1, R_2, R_3, R_4, R_5, M_1, M_2, M_3, Cu_1, and Cu_2 + 2d A; a wide spot between M_1 and M_2 on the posterior fringe and a small spot at about the basal one-sixth of the wing; suggestions of three sinuous bands crossing the width of the wing, the first starting from the large spot on the anterior fringe, the second from the small spot at the middle of the anterior fringe, the third from the white spot at the tip of R_1. A denuded wing is conspicuous for the presence of distinctly pigmented areas on the veins, the pigmented areas are distributed as follows: On the tip of Sc and at the end of all the veins mentioned below; also a wide area on the fork of R_2R_3 and a small area before the fork; a small area midway between the fork and tip of R_2 and between the fork and tip of R_3; on R_4 there are about five dark areas; on R_5 one dark area basally; on M_1 there are four areas; on M_2 and M_3 there are two and five, respectively; on Cu_2 + 2d A one large area close to the one at its tip; the whole of 3d A is heavily pigmented. Wing venation: Sc long; origin of R_2R_3 at the level of r-m; fork R_2R_3 about the middle of the wing, much closer to fork M_1M_2 than to r-m. Stem of M_1M_2 of about same length as stem of R_2R_3, both forks a little after the extremity of Cu_2 + 2d A. Coxæ and trochanters fuscous brown, hairs almost white. Femora of fore-legs strongly developed, sides in posterior view with three rows of bristles; pile on the outer surface gray, with scattered whitish hairs on the basal one-half of the anterior surface; undersurface with gray hairs; apically with a narrow white band. Fore tibiæ with dark gray hair and three distinct white bands, the band at basal one-third widest, the apical band narrow but distinctly snow white. First tarsal segment with dark gray hairs like those on the fore tibiæ; narrow, though very distinct, white bands basally and apically; the posterior edge with two rows of white scalelike hairs. Second tarsal segment white, the following two segments dark gray, the undersurface lighter. Middle and hind femora yellowish white on the upper surface, the apical one-third with dark gray hairs, without bristles on posterior border. Tibiæ and tarsi of mid- and hind legs with dark gray and white bands as on the forelegs.

Abdomen broadly bronzed dorsally, blackish beneath, the incisures pale brown; dorsum wholly covered with long, white, or pale yellowish white, hairs; venter basally with pale white hairs, towards the posterior end with dark gray hairs; lateral margin with either white, or a mixture of white and dark gray, hairs. Hypopygium of same coloration as the dorsum of the

abdomen with a mixture of white and dark gray hair. Ninth tergite about twice as broad as long, caudal flap triangular with distal end bluntly rounded. Inferior appendages stout, cylindrical, gently curved inwardly, almost twice as long as broad, bearing a tuft of from eight to ten spinules, sometimes arranged in rows of two or three; the spinules flat, heavily chitinized basally, their apices with very fine serrations. First segment of superior appendages stout, barrel-shaped, bearing two, long, slender spines on its inner surface; second segment strongly curved inwardly, its apex bearing a short spine. Ædeagus composed of two, slender, pointed processes, the longer about one-third longer than the shorter, their bases fused into a broad and heavily chitinized structure.

Length of body, 1.71 mm; width of head, 0.40; length of wing, 1.58; width of wing, 0.78; length of antennæ, 1.52.

Female.—Eyes at frons separated by a distance equal to twice the diameter of one facet. Antennæ differing from those of the male in that the nodes are much smaller and shaped like a club with a short neck. Whorls of white hairs on antennal segments 2, 8, 11, 12, and 16, the whorls on the remaining segments are dark gray and not appressed; basal segment of antennæ about twice as long as broad; 2 globular; 16 with a single terminal spike. Sensory spines with four to five branches, not continuous around the node but diametrically opposed. Thorax and abdomen of same coloration and structure as in the male. Wing venation, spots and speckling on the legs similar to those of the male. Ventral plate shallowly emarginate at apical end, terminating on each side in a well-marked lobe; each lobe bearing several spines. Anal flap attached to the ventral plate with a group of six fairly long spines (best seen under oil immersion).

Length of body, 2.03 mm; width of head, 0.43; length of wing, 1.92; width of wing, 0.80; length of antennæ, 1.16.

CALIFORNIA, Pacific Groove, May 6, 1906 (*J. M. Aldrich,* type of *Ps. littoralis* Dyar, type, *29388 U. S. National Museum*). ALASKA, Anchorage, June 15, 1921 (*J. M. Aldrich,* type of *Ps. aldrichana* Dyar, type, *29389 U. S. National Museum*). VIRGINIA, Onley, August 17, 1933 (*F. C. Bishopp's* light trap); Exomore, August 20, 1933 (*F. C. Bishopp's* light trap). MARYLAND, Solomon Island, August 7, 1933; College Park, August 14 and 17, 1933; Chesapeake Beach, July 28 and 29, 1933; Snowhill, July 13, 21, 25, and 27, 1933; August 1, 1933; Sep-

tember 26, 1933; Indian Head, August 6, 10, 12, 15, 16, and 20, 1933; Chestertown, July 22, 1933; Annapolis, St. John College, August 12, 1933 and September 7, 1933; Easton, August 16, 1933, and September 11, 1933 (all specimens examined from Maryland are from *F. C. Bishopp's* light trap). DISTRICT OF COLUMBIA, Washington, November 25, 1914 (*N. Banks*, type of *Ps. autumnalis* Banks, type, *13525 U. S. National Museum*), September 23, 1906 (*F. Knab*), October 8, without year (*Chittenden*).

The characteristic dark gray and white spots of the wings, the conspicuous annulated legs, and the structure of the male hypopygium of the specimens of *Ps. littoralis* Dyar, at once place this species as a synonym of *Ps. autumnalis*. *Psychoda aldrichana* was described by Dyar from a single denuded specimen. He described the legs of this specimen as dark, without mentioning the white and black bands characteristic of *autumnalis*. The denuded specimen also shows the faded mottled appearance of the wing produced by the black pigments on the wing veins, this character being observed in no other species of *Psychoda* except *autumnalis*.

PSYCHODA ALBIPUNCTATA Williston. Plate 5, figs. 1 to 6.

Psychoda albipunctata WILLISTON, Ent. News 55 (1893) 113.
Telmatoscopus meridionalis EATON, Ent. Mo. Mag. (1894) 195.
Psychoda snowii HASEMAN, Trans. Am. Ent. Soc. 33 (1907) 311–312.
Telmatoscopus albipunctatus (Williston) EDWARDS, Entomologist 66 (1928) 32.
Psychoda erecta CURRAN, Cat. Ins. Jam. Dept. Agr., Jamaica, Ent. Bull. No. 4, Parts 1 and 2, Append. (1926) 102.

Male.—Occiput and frontal triangle bronze, covered with whitish hairs which have grayish tints near their apices. Eyes at frons separated by a distance equal to about one and one-half times the diameter of one facet. Clypeus also bronze; slightly convex; with slight emargination on anterior margin; much broader than long; lateral margin with a row of four stout hairs. Proboscis bulblike, a little longer than the first palpal segment, clothed with short grayish black hairs. Paraglossæ with seven short teeth on each side of the lobe and over twelve long stout spines. Furca not well chitinized. Palpi dark brown, with dark gray hairs; palpal segments in the proportion of 5 : 20 : 12 : 15. Antennæ of sixteen segments, pale brown, with snow-white hairs; hairs on the nodes slightly compressed, although a few long hairs tend to spread outward; segment 1 stout, slightly longer than 2, which is globular, the whole surface

of segments 1 and the basal half of 2 covered with dark scalelike hairs; nodes of the middle segments of the antennæ much wider than long; last segment of similar shape except that the internode terminates in a spike with fine short hairs. Sensory spines on segments 3 to 16 composed of two long anterior branches, one on each side of the node.

Thorax pale brown; dorsum densely covered with whitish hairs which have grayish tints near their apices. Wings ovate, somewhat angulated at tip, about twice as long as broad. Hairs at basal one-seventh in the region of the base of the veins whitish, the hairs on the veins erect. Hairs on the semichitinous pad on costa and hairs on the alula whitish, some having the usual grayish color near the tips. Base of costa with blackish hairs, whitish at their apices, followed by a large patch of long white hairs. Anterior fringe brown, posterior darker. White pattern on the wings as follows: A large patch on the fork of $R_2 + R_3$ and another on the fork $M_1 + M_2$, the hairs on the latter nearly all erect; small patches at basal one-third of veins R_2 and R_3; small patches at about two-thirds of veins R_4, M_1, M_3; a medium-sized patch near the tip of vein $Cu_2 + 2d$ A. Tips of all veins except R_5 and $Cu_2 + 2d$ A with a few whitish hairs, which sometimes extend to the wing fringe. A distinct patch of erect blackish hairs before the white patch at the fork $R_2 + R_3$ and fork $M_1 + M_2$. Apex of wing also blackish. Wing fringe between whitish spots of tips of veins either blackish or smoky. Sc about as long as vein R, ending about the level of the origin of R_2R_3 on R_4. Origin of R_2R_3 distinctly before r-m. Fork M_1M_2 much closer to r-m than to fork R_2R_3. Knob of halteres blackish. Forelegs pale brown with white ring near the apical joint; tibiæ with short blackish hairs intermingled with white scalelike hairs; apically, near the joint, a ring of white scalelike hairs; tarsal segments with a prominent white ring on the apex of the first tarsal segment; last four tarsal segments blackish. Middle and hind legs similar to the forelegs, except that the apices of all the tarsal segments have white or nearly white hairs; tip of the last tarsal segment of the hind legs yellowish.

Abdomen blackish with dark yellowish brown hairs intermingled with yellowish white hairs. Hypopygium with long dark gray hairs. Ninth tergite heavily chitinized, about twice as long as broad, slightly longer than the inferior appendages. Anal flap evenly rounded, covered with short fine hairs. Inferior appendages stout, gradually tapering, apex bearing twelve

or more short spinules arranged in a single group. Basal segment of superior appendages stout, about as broad as long; apical segment slender, rather swollen basally, slightly curved at apex, which is pointed, bearing one or two short spines. Ædeagus consists of two well-chitinized, rather clawlike arms, loosely connected at their tips; basally the two arms terminate in a strong posterior arm.

Length of body, 2.00 mm; width of head, 0.69; length of wing, 2.50; width of wing, 1.23; length of antennæ, 1.00.

Female.—Differs from the male as follows: White scaling on antennal segment 2 very prominent; hairs on the nodes of the antennæ not very thickly set as in the male; white patches, especially the V-shaped, bandlike, white patches, at about the middle of the wing, more distinct than in the male; knee spots very conspicuous; dorsum of the abdomen near the posterior end with more white hairs; venter with blackish hairs. Ventral plate reddish brown, shallowly emarginated at apex.

Length of body, 2.50 mm; width of head, 0.80; length of wing, 2.80; width of wing, 1.50; length of antennæ, 1.90.

I have studied specimens of *Ps. albipunctata* in the United States National Museum from the following localities:

TEXAS, Brownsville, 1923 (*R. E. Tarbett*); Dallas, June 11, 1928 (*F. C. Bishopp*); Austen, 1919 (*J. M. del Curto*); Cuero, June, 1918 (*C. H. T. Townsend*). FLORIDA, Bradentown, March, 1913 (*M. C. Van Duzee*); Orlando, July 22 to 30, 1933 (*F. del Rosario*). LOUSIANA, Madison Parish, Tallulah, September, 1932 (*P. A. Woke*). BAHAMAS, Nassau, January, 1915 (*H. G. Dyar*). BERMUDA, October 24, 1931 (*H. H. Whetzet*). PANAMA CANAL ZONE, Summit, May, 1927 (*J. Zetek*). PORTO RICO, Cayey, August, 1928 (*W. A. Hoffman*); Rio Piedras, August 5, 1922 (*F. Sein*). HAITI, Port-au-Prince, November, 1928 (*R. C. Smith*). MEXICO, Oaz., Tuxtepex (*J. Camelo G.*); Oaz., Rio Antonio (*F. Knab*); Cordoba (*F. Knab*). WEST INDIES, St. Domingo, San Francisco Mountains, September, 1905 (*A. Busck*); Tobago Island, July (*A. Busck*); Trinidad, Port of Spain, June, 1911 (*A. Busck*). COSTA RICA, Alajuela, August, 1921 (*A. Alfaro*). BRITISH GUIANA, Georgetown, December 16, 1913 (*H. W. B. Moore*). JAMAICA, Kingston, September 24, 1903 (*M. Grabham*). CUBA, Baracao, September, 1907 (*A. Busck*).

Dyar (1926) states, "this species is widespread through the West Indies, and what is apparently the same has been taken in Florida, Texas and South Carolina, but the male genitalia

not compared." Haseman described as a new species (*Ps. snowii*) specimens collected at Galveston, Texas, differentiating this species from *Ps. albipunctata* by size, color pattern of the wings, snow-white antennæ, and knotted hair. Tonnoir (1920), who studied the collection of Psychodidæ in the British Museum, has published figures of the male wing and hypopygium of *Telmatoscopus meridionalis* Eaton. Edwards (1928) says, "Since Tonnoir's notes on the subject were published (Rev. Zool. Afr. Vol. VIII, p. 137, 1920), Tonnoir concluded that Willinston's *Ps. albipunctata* from Cuba is the same species, which should therefore be known as *Tel. albipunctata* (Will.)." In the same paper Edwards states, "It seems worth while to call attention to Tonnoir's discovery (that *T. meridionalis* Eaton is very widely distributed, not only throughout Africa, but also in the Mediterranean region, South America and the West Indies) because the same species has been re-described recently by Curran as *Ps. erecta;* the type (from Jamaica) has been received at the British Museum and proves to be a typical example of *T. albipunctatus.*" The hypopygia of the males, tips of the antennæ, wing venation, and color pattern of the wings of the specimens of *albipunctata* which I have studied, agree with the descriptions given by Haseman for *snowii* as well as with the figures given by Tonnoir for *T. meridionalis.*

PSYCHODA FUMATA Knab. Plate 5, figs. 7 to 10.

Psychoda fumata KNAB, Proc. U. S. Nat. Mus. 46 No. 2015, 1914 (1913) 103.

Male.—Occiput dark brown, rather broad, with gray hairs; a row of ten to twelve stout hairs on anterior margin. Eyes at frons nearly touching, distance of separation about one-third the diameter of one facet. Frontal triangle pale brown, clothed with yellowish gray hairs, these hairs confined to a circular area between the antennal fossæ. Clypeus brown, about twice as broad as long, lateral margins with six spines arranged in a single row, the rest of the surface covered with dark gray hairs directed toward the proboscis. Proboscis smoky, slightly longer than the first palpal segment, covering of hairs mostly dark gray. Paraglossæ bulblike, inner surface with three short teeth, outer surfaces with six long spines. Posterior stem of theca longer than its anterior arm. Palpi light brown with yellowish hairs; palpal segments in the proportion of 15 : 33 : 37 : 38. Antennæ of sixteen segments, brown, nodes with long gray hairs distinctly spreading outward; segment 1

slightly longer than 2, which is nearly spherical; node of segment 3 somewhat tapering posteriorly; nodes of segments 4 to 12 flask-shaped, internode longer than the node. Segment 13 globular, with a very short neck; segments 14 and 15 almost equal in size, spherical, with a shallow constriction separating them; segment 15 with a small toothlike projection bearing a small spine near its internode. Segment 16 rather ovoid with three to five short spines at its tip. Sensory spines on segments 3 to 13 composed of two long anterior branches and one posterior branch; the branches curved near their bases; anterior branch reaching to about two-thirds of the preceding node.

Mesonotum pale brown, clothed with long, erect, dark gray hairs, yellow near their bases. Wings lanceolate, over twice as long as broad, dark gray, with brownish tints; white patches near tips of R_1, R_2, R_3, M_3, and Cu_1; black spots on apices of R_1, R_2, M_3, Cu_1, and Cu_2 + 2d A. Sc short, ending before the level of r-m. Origin of R_2R_3 on R_4 not very distinct and apparently before the level of r-m, the fork R_2R_3 after the middle of the wing. Fork R_2R_3 about as close to r-m as it is to fork M_1M_2. Knob of halteres blackish, stem yellowish. Legs pale brown, with smoky hairs. Fore and hind tibiæ with white bands at apex of the segment; the apical end of the first tarsal segment with white ring; the remaining tarsal segments uniformly blackish. Midtibiæ with white bands on their apices; first and second tarsal segments with white rings.

Abdomen yellowish brown, thickly clothed with hairs similar to those on thorax. Hypopygium pale brown, with dark hairs. Ninth tergite slightly longer than broad; width equal to the length of inferior appendages; anal flap appearing as two lobes, covered with short fine hairs. Inferior appendages moderately swollen basally and slightly tapering; apical portion with three short spines; terminal spinule about one-half the length of the appendage. Basal segment of superior appendages broad and stout, with a few hairs on the outer margin; apical segment longer than the basal segment, swollen basally and tapering to a slender apex, which is more or less pointed and bears two short spines. Ædeagus composed of one long tubular piece, lancetlike, and a short piece slightly curved at its apex. Basally the two pieces are fused together into a short heavily chitinized arm.

Length of body, 1.98 mm; width of head, 0.50; length of wing, 2.30; width of wing, 1.00; length of antennæ, 0.90.

MEXICO, Cordoba, 3 males, bred from bromeliads (*F. Knab*, type, *15934*, *U. S. National Museum*).

PSYCHODA HELICIS Dyar. Plate 5, figs. 11 to 15.

Psychoda helicis DYAR, Proc. Ent. Soc. Wash. **31** (1929) 63–64.

Male.—Occiput narrow, dark brown, covered with dark gray hairs. Eyes at frons almost touching. Frontal triangle broad. Clypeus wide, provided with five spines on the margin close to the eyes; shallowly emarginate at its anterior margin. Proboscis slightly longer than first palpal segment. Furca and theca heavily chitinized. Paraglossæ with three pairs of small spinelike teeth. Palpal segments in the proportion of 4 : 7 : 9 : 9. First palpal segment stout with a small patch of thick sensory hairs at about its basal half; remaining segments except the last segment have no sensory patch of hairs. Antennæ of sixteen segments; segment 1 short and strongly united to 2, which is globular; segments 3 to 12 flask-shaped; nodes more or less rounded; segment 13 with short neck; 14 and 15 of same size with short neck; 16 ovoid. Sensory spines diametrically opposed on the anterior end of each node of segments 3 to 14; each set of sensory spines is made up of two parts, each part having five, slender, leaflike branches, which are apparently intimately connected at their apices.

Thorax dark brown (all specimens denuded). Wings lanceolate, almost two and one-half times as long as wide, slightly pointed at apex. Sc about as long as the semichitinous pad above it. Origin of R_2R_3 on the same level as r-m; fork R_2R_3 a little before the middle of the wing, on the same level as the ending of vein Cu_2 + 2d A, and much closer to fork M_1M_2 than to r-m. Vein R_5 well chitinized. Fork M_1M_2 before the middle of the wing, closer to the base than fork R_2R_3. Cell C + Sc darker and highly pigmented. Legs dark brown, apparently with dark gray hairs.

Abdomen dark brown, ninth tergite nearly as long as broad, slightly narrower at the base, and gradually distending medially; caudal flap semicircular in outline, distinctly hairy. Inferior appendages stout, about as long as the ninth tergite; outer margin covered with a thick set of short spines; inner surface with two long slender spines at its basal one-third; apex bearing two long spinules about two-thirds the length of the appendages. Basal segment of superior appendages broad, strongly developed; inner margin with a group of six fairly long spines; second segment clawlike; inner margin with a single, terminal,

hairlike spine. Ædeagus consisting of three pointed processes, the median piece directly connected to a heavily chitinized rod, the two other pieces slightly enlarged basally, both connected to a basal plate posteriorly at the bases of the superior appendages and ninth tergite.

Length of body, 1.21 mm; width of head, 0.38; length of wing, 1.45; width of wing, 0.60; length of antennæ, 1.24.

Female.—Resembles the male in coloration, structure of the antennæ, and wing venation. Eyes at frons separated by a distance equal to the diameter of one facet. Palpi with the three basal segments with a patch of sensory hairs, the patch on the second segment longest, running almost the whole length of the segment. Female genitalia with the ventral plate in the form of a tubular elongation covered with thick spines and microtrichia. Ovipositor reduced to two, broad, platelike pieces with blunt ends.

Length of body, 1.30 mm; width of head, 0.36; length of wing, 1.45; width of wing, 0.67; length of antennæ, 0.78.

CUBA, Central Jarona, September 26, 1927, males and female, type, *41186, U. S. National Museum* (*H. K. Plank,* through W. A. Orton, Division of Tropical Plant Research, reared from snails). MARYLAND, Solomon Island, August 9, 1933 (*F. C. Bishopp's* light trap); Snowhill, September 26, 1933 (*F. C. Bishopp's* light trap).

PSYCHODA TRIDACTILA Kincaid. Plate 5, figs. 16 to 19.

Pericoma tridactila KINCAID, Ent. News 10 (1899) 32.

Male.—Occiput dark bronze, densely clothed with long, erect, gray hairs. Eyes at frons separated by a distance about one-fourth less than the diameter of one facet. Palpi brown with short dark gray hairs; palpal segments in the proportion of 16 : 7 : 7 : 9. Paraglossæ bulb-shaped with four short spines on the inner surface of each lobe. Posterior stem of the theca nearly three times the length of the anterior arms. Antennæ of sixteen segments; nodes bronzed, verticils dark gray and almost compressed; segment 1 nearly as long as segment 2, which is spherical; segments 3 to 12 with their nodes flask-shaped, the diameter of the node about equal to the length of the internode; segment 13 with the node nearly of the same size as the node of segment 12 but with a very short internode; segments 14, 15, and 16 of about the same size, smaller than any of the nodes of the antennæ, separated from each other by a short, indistinct internode. Sensory spines on segments 3 to 13 of the usual

type, composed of two long anterior branches and one posterior branch.

Mesonotum bronze with gray hairs; pleuræ brown, with a few short gray hairs. Wings ovate, slightly acute at apex, wholly covered with fine gray hairs except for an irregular yellowish white band across the middle. Hairs on semichitinous pad close to the costa, dark gray. Anterior fringe uniformly grayish. Posterior fringe also grayish; towards the tip with indication of two yellowish areas. Tip of veins R_3, R_4, M_1, M_2, and M_3 with yellowish white hairs. Sc short, slightly broad at the tip, somewhat overlapping the base of R_1. Vein R_1 ending almost on the level of fork R_2R_3. Origin of R_2R_3 a little behind r-m, the fork being loosely connected. Fork M_1M_2 also loosely connected, distinctly before the middle of the wing and before the ending of vein $Cu_2 + 2d$ A. Halteres dark brown; knobs with gray hairs. All legs light brown, covering of hairs gray, except on the tarsal segments, which appear yellowish when examined under diffused light.

Abdomen light bronze, dorsum with grayish hairs, sides and venter with yellowish gray hairs. Ninth tergite about twice as long as wide; anal flap small, evenly rounded, with a broad area shaped like a bag basally, surface covered with fine microtrichia. Inferior appendages cylindrical, slightly tapering apically to a rounded end; on the inner margin, near the base, is a long spinelike hair; apex bearing three long, clavate, somewhat equidistantly placed spinules, two of the spinules long, about two-thirds the length of the appendages, the other spinule slightly shorter than the outer two spinules. Superior appendages of two segments; basal segment cylindrical, about twice as long as broad; second segment slightly longer than the first, clawlike, tip pointed, with two rows of short, slender, spinelike hairs; extreme tip with a long hair, which is about two-thirds the length of the segment. Ædeagus composed of five pointed processes; one centrally placed, rather tubular piece, with an anterior median groove and ending posteriorly in a rounded end; this piece surrounded by four, slightly shorter, pointed pieces with their bases strongly united.

Length of body, 1.90 mm; width of head, 0.40; length of wing, 2.36; width of wing, 0.91; length of antennæ, 1.45.

Since no female has been examined, the original description of the female is here reproduced.

Female: Body light brown, densely clothed with gray hair. Wings ovated, one and one-half times as long as broad, apex moderately acute, clothed over the whole surface with gray hair, except an irregular band of white across the middle; fringe with basal third gray, remainder white, as long as the width of three cells; length of wing 2.5 mm. Legs light brown, clothed with gray hair and scales. Antennæ as long as the width of the wing, 16-jointed, with dense whorls of gray hair upon the nodes; joints 1–2 not larger than succeeding one; joints 3–15 globular separated by slender pedicles which are slightly longer than the length of the nodes; joints 14–16 minute, closely opposed. Ventral plate longer than broad, sides not emarginate, narrowing strongly toward the apex which is bilobate.

WASHINGTON, Seattle, 1 male, paratype, March 24, 1899 (*T. Kincaid*); Longmire Springs, 1 male, July 14, 1917 (*H. G. Dyar*).

PSYCHODA QUADRIPUNCTATA Banks. Plate 6, figs. 1 to 4.

Psychoda quadripunctata BANKS, Proc. Ent. Soc. Wash. 8 (1906) 148–151.

Female.—Head and thorax dark brown; occiput narrow, with short white hair. Eyes at frons separated by a distance equal to the diameter of three facets. Frontal triangle broadly widening toward the clypeus, covered with long, recumbent, dark grayish hairs; clypeus over twice as long as broad, with dark gray hairs, like those on the frontal triangle. Proboscis slightly longer than the first palpal segment, with dark grayish pile near the tip. Paraglossæ very much enlarged into bulblike lobes; each lobe apparently without any visible trace of the usual small spinelike teeth. Theca heavily chitinized, stem over three times the length of the anterior arms. Furca well chitinized, like the theca. Palpi dark brown, with short, recumbent, dark grayish white hairs similar to those found on the head. Palpal segments in the proportion of 7 : 10 : 9 : 14. Antennæ rather slender, of sixteen segments; nodes of basal one-half of the antennæ pale brown, verticils slightly compressed, pale brown; nodes of the apical portion lighter, verticils tending to spread outward. Second segment with grayish white hairs; diameter of the node equal to the length of the internode; terminal segment with terminal spike about as long as the diameter of the segment, covered with fine microtrichia. Sensory spines like those of *Ps. autumnalis* or *Ps. nigra* (female), with fingerlike branches usually from three to five in number.

Thorax dark brown, anterior mesonotum with white hairs. Pleuræ also dark brown. Knob of halteres wide, dark brown, with short, dark gray hairs; stem slender, pale yellow. Wings

lanceolate, over twice as long as broad, tip slightly angulated. Vestiture of brown or black and white hairs distributed as follows: A strip of erect white hairs occupying about basal one-third of R_1; a long strip of erect white hairs starting from origin of fork R_2R_3 and extending to about the middle of R_2 and R_3; another strip of erect white hairs on basal one-half of vein R_4; a short strip of erect white hairs on basal one-sixth of M_1 and followed by another shorter white strip at about the middle of the same vein; very distinct long strip of erect white hairs occupying nearly two-thirds of vein $Cu_2 + 2d$ A; black spots on tip of all veins except $Cu_2 + 2d$ A; black spots also located on R_2 and R_3 immediately following the ending of the white erect hairs, on M_2 just below the white on the middle of M_1; another black spot following the white on $Cu_2 + 2d$ A. All the other hairs on the veins are brown, except those on the tip of the anterior and posterior fringes, which are distinctly white, the white strip longer on the posterior than on the anterior fringe. Sc long, ending before the level of r-m; origin of $R_2 + R_3$ at the same level as r-m; forks R_2R_3 and M_1M_2 almost in line with the ending of $Cu_2 + 2d$ A. Fork R_2R_3 nearer to r-m than the fork M_1M_2. All legs brown, clothed with dark gray hairs except the apical third of all the tarsal segments, which are grayish or grayish white when examined under diffused light.

Abdomen dark brown, dorsum and sides with whitish hairs, towards the tip with grayish white hairs. Venter with a few black hairs. Ventral plate slightly narrowing near the base; lobes well produced, depth about one-third the distance between the lobes. Ovipositor about two and one-half times the width of the ventral plate, pointed, inner surface with a single row of short hairlike spines.

Length of body, 2.00 mm; width of head, 0.50; length of wing, 2.36; width of wing, 0.98; length of antennæ, 1.20.

VIRGINIA, Glencarlyn, 1 female, May, 1909 (*F. Knab*), determined by N. Banks as *Ps. quadripunctata* Banks.

PSYCHODA OLYMPIA Kincaid. Plate 6, figs. 5 to 8.

Psychoda olympia KINCAID, Ent. News 8 (1899) 144.

Pericoma olympia (Kincaid) HASEMAN, Trans. Am. Ent. Soc. (1907) 305–306.

Male.—Occiput bronze, densely covered with erect, dark gray hairs. Eyes at frons almost confluent, separated by a very fine line. Frontal triangle broad toward the clypeus, covered with light brown hairs arranged in groups in the middle of

the triangle; clypeus about twice as broad as long, slightly convex; convex surface covered with light brown hairs. Proboscis brown, slightly longer than the first palpal segment; lobes of paraglossæ well expanded, inner surface with eight short spinelike teeth on each lobe; outer margin with over twenty long and short spines. Theca well chitinized, stem a little longer than the anterior arms. Furca appearing as a broad chitinized strip. Palpi brown, with short dark gray hairs. Palpal segments in the proportion of 6 : 6 : 6 : 11. Antennæ of fourteen segments, nodes bronzed, verticils from each segment extending to the middle of the node of the preceding segment; segment 1 slightly longer than broad; 2 subglobular; 3 with the node elongated, the widest diameter at about the middle of the segment; segments 4 to 11 with long, slender internodes, the length of the internode longer than the diameter of the node; segment 12 with a short neck; segment 13 subglobular, smaller than 11 and with a very short neck; segment 14 slightly smaller than 13 and with a very small blunt projection bearing microtrichia. Sensory spines on segments 3 to 12 shaped like a slender, leaflike structure, two on each side of the node.

Mesonotum bronzed, densely covered with long dark grayish hairs (whitish when viewed from the sides); pleuræ pale brown with short whitish hairs and a few, long, dark gray hairs. Halteres bronzed with short dark gray hairs. Wings lanceolate, slightly angulated at tip. Anterior fringe mouse gray, tuft near the base mostly of long grayish hairs. Whole of Sc with erect white hairs. Bases of M_1M_2 and $Cu_2 + 2d$ A also with erect white hairs. Tips of all veins with dark mouse gray spots formed by dark gray hairs. Towards the apex an irregular black band runs across the wing starting from vein R_1. A patch of white hairs immediately behind the black band on the level of the fork of R_2R_3; an indistinct black fascia running across the width of the wing at about the middle. Hairs on the fork M_1M_2 mostly black or dark mouse gray, towards the base the hairs are dark brown. Posterior fringe longer than the anterior fringe and tending to spread. Sc long, ending at about the level of r-m. Origin of $R_2 + R_3$ on R_4 distinctly before r-m; fork R_2R_3 in line with the ending of $Cu_2 + 2d$ A, farther from r-m than fork M_1M_2. All legs brown with dark hairs; femora whitish when viewed by reflected light; tibiæ with a few scattered white hairs; tarsal segments with short grayish hairs.

Abdomen brown with long grayish hairs on the dorsum; towards the hypopygium the hairs become darker; sides and venter pale brown with grayish hairs. Ninth tergite slightly longer than broad, widening medially; caudal flap elongated and overlapping another small flap. Inferior appendages longer than the ninth tergite, swollen basally and gradually tapering toward the apex; apical end bearing thirteen to fifteen long and short spinules, the longest spinule about two-thirds as long as the swollen appendage; surface of the inferior appendages with hairlike spines. Superior appendages with the basal segment cylindrical, slightly curved inward and about twice as long as broad, with the inner surface near the base bearing a group of five short spines; apical segment clawlike, a little longer than the basal segment. Ædeagus consists of a tubular stem and anterior looplike portion which is inclosed by a thin chitinized sheath.

Length of body, 2.95 mm; width of head, 0.56; length of wing, 3.18; width of wing, 1.09; length of antennæ, 2.25.

WASHINGTON, Seattle, 1 male, March 27, 1898 (*T. Kincaid*), determined by T. Kincaid as *Ps. olympia* Kincaid.

PSYCHODA SNOWHILLI sp. nov. Plate 6, figs. 9 to 13.

Male.—Eyes at frons almost confluent. Frontal triangle apparently with the covering of hairs confined to a circular area between the antennal fossæ. Paraglossæ with four spinelike teeth on the inner surface of each lobe; outer surface of the lobe with about nine long spines. Palpal segments in the proportion of 5 : 7 : 8 : 9 : 5. Antennæ of fifteen segments; segment 1 longer than broad; 2 subspherical, about as broad as segment 1; segment 3 with the greatest diameter of the node at about the middle of the segment, with a subnode before the usual enlarged node, the length of the subnode equal to the length of the internode; segments 4 to 13 with the diameter of the node equal to the length of the internode; segment 14 with a short neck; segment 15 ovoid, about one-half as long as 14, with a short neck bearing two short spines at its apex. Sensory spines arranged like a comb, with an anterior and posterior row of ten to fourteen branches. The two processes are attached on each side of the node and almost encircle the node.

Wings lanceolate, pointed at apex, over twice as long as broad. Sc short. R_1 ending after the middle of the wing. Origin of R_2R_3 on R_4 very distinct and before r-m, the fork R_2R_3 before fork M_1M_2 and before the middle of the wing.

Fork M_1M_2 nearer to fork R_2R_3 than to r-m. Both forks before the ending of $Cu_2 + 2d$ A.

Hypopygium: Ninth tergite over twice as broad as long; caudal flap almost rounded at its tip and with a short slender stem. Inferior appendages almost tubular, not curved, with a basal enlargement near the point of attachment to the ninth tergite; apex carrying three short spinules and a few short spines; those spines have serrated edges. Basal segment of superior appendages stout and well developed; apical segment swollen near the base and acutely pointed at its tip; near the tip with about five short and two long spines. Ædeagus consists of three pieces—a longer piece and two slightly shorter pieces coiled to the longer; posteriorly the three pieces unite into a single flat piece.

Length of body, 1.00 mm; width of head, 0.36; length of wing, 1.62; width of wing, 0.61; length of antennæ, 1.21.

MARYLAND, Snowhill, 1 male, July 25, 1933 (*F. C. Bishopp's* light trap).

With one denuded specimen to furnish data, the establishment of a species is a risky proposition. But when a form shows characters evidently different from any other known form, it seems quite permissible to describe and name the individual. The species is distinguished by the shape of the tip of the antenna, which bears a short spike carrying two short spines, by the peculiar arrangement of the sensory spines, by the shape of the third segment of the antenna, and by the form of the hypopygial appendages.

PSYCHODA BISHOPPI sp. nov. Plate 6, figs. 14 to 17.

Male.—Occiput brown with brown hairs. Eyes at frons separated by a distance equal to one-half the diameter of one facet; facets near the point of separation arranged in four rows. Frontal triangle dark brown with yellowish gray hairs, broadly widening towards the clypeus. Clypeus brown with yellowish white hairs, longer than those found on the palpi or proboscis. Proboscis brown with short yellowish gray hairs; proboscis slightly longer than the first palpal segment. Paraglossæ with four spinelike teeth on inner surface of each lobe and about seven long spines on outer surface. Palpi light brown with short, recumbent, yellowish gray hairs; palpal segments in the proportion of 12 : 23 : 28 : 33. Antennæ of sixteen segments; segment 1 about as long as broad; 2 subglobular; segments 3 to 13 with the diameter of the node equal to the length

of the internode; segment 14 intimately united to 15, which is ovoid and small. Sensory spines of the usual type having two anterior branches and one posterior branch.

Thorax bronzed, mesonotum with grayish hairs; pleuræ yellowish, anterior margin with a thick covering of gray hairs, hairs on the root of the wing and around the spiracle yellowish. Halteres dark yellow with dark gray hairs. Wings ovate, somewhat pointed at the tip, over twice as long as broad. Vestiture of hairs grayish throughout. Sc short. Origin of R_2R_3 on the same level as r-m, the fork R_2R_3 after the ending of $Cu_2 + 2d$ A. Fork M_1M_2 before the ending of $Cu_2 + 2d$ A, closer to fork R_2R_3 than to r-m. Legs uniformly clothed with grayish hairs; tarsal segments, especially around the joints, appear whitish in certain lights.

Abdomen pale brown, incisures whitish, covering of hairs grayish; venter with a few whitish hairs. Ninth tergite a little longer than wide; caudal flap evenly rounded with distinct microtrichia. Inferior appendages rather tubular but slightly enlarged basally; apically bearing five spinules of equal size, the length of the spinules a little over one-half the length of the appendage. Basal segment of superior appendages longer than wide, on the inner surface near the base is a group of about seven short spines; apical segment about as long as the basal segment, slender and pointed, the apex bearing a single hairlike spine. Ædeagus consists of one short piece, slightly notched at its extreme tip, and two pointed lateral pieces which have a broad base giving a triangular shape. The whole ædeagus is triangular in general appearance, except for the posterior prolongation which is more or less tubular.

Length of body, 1.25 mm; width of head, 0.36; length of wing, 1.64; width of wing, 0.67; length of antennæ, 1.23.

MARYLAND, College Park, 2 males, September 9, 1933; Chesapeake Beach, 1 male. All the specimens were collected in F. C. Bishopp's light trap.

In addition to the species described above there are several species described by other authors as belonging to the genus *Psychoda* that in all probability belong to the genus *Pericoma*, and some species described as *Pericoma* in all probability really belong to *Psychoda*. In the absence of the types it is very difficult to identify the species. All the descriptions, especially those given by other authors, are very deficient, so that it is

almost useless to attempt to identify the species without examining the types. It must be left to future workers who have access to the types (if they still exist, which is doubtful) to determine the synonymy. A few remarks on these species, however, may not seem out of place here.

PSYCHODA ANGUSTIPENNIS Williston.

This may be the same species as *Ps. quadripunctata* Banks, as the author mentions the "wing having a small tuft of white at the extreme tip; another larger one on each side beyond the middle, and yet another towards the base on the posterior margin," but these would be the only characters by which the identity could be established, as the remaining parts of the description may be considered too general. St. Vincent, West Indies. Location of type unknown.

PSYCHODA PALLENS Williston.

This species has been made a synonym of *Ps. phalænoides* Linn. by Dyar (1926), who gave no reason whatsoever for doing so. Since Williston described the antennæ as rather slender, he may have been dealing with a *Pericoma.* The presence of "a minute blackish spot at the tip of the wing" might help to identify this species to a certain extent. St. Vincent, West Indies. Location of type unknown.

PSYCHODA PUNCTATELLA Williston.

From the description of the wing as "having eight small black spots on the margin of the wing" and by the fact that the antennæ were said to be stout and thickly clothed with white hairs, this species might be either *Ps. albipunctata, Ps. superba,* or *Ps. autumnalis,* although in these species the legs have rings or bands of white hairs; the legs of *punctatella* were said to be grayish brown (probably referring to the color of the integument). Vera Cruz, Mexico. Location of type unknown.

PSYCHODA ANNULIPES Johnson.

Judging by the mention of the wing as having "numerous small tufts of erect black hairs along the veins in the center of the wing and by the tibiæ being conspicuous annulated" it seems probable that this is nothing else than *Ps. autumnalis.* Should this prove to be the case, the form to which the name *Ps. autumnalis* is here assigned would become *Ps. annulipes* Johnson. Ormond, Florida. Holotype in Johnson's collection; allotype in Mrs. Slosson's collection.

PSYCHODA ANTENNALIS Williston.

This evidently is a true *Psychoda* as shown by the words "antennæ stout, the joints moniliform." St. Vincent, West Indies. Location of the type unknown.

PSYCHODA SQUAMOSA Johnson.

The fact that the wing was described as being grayish and quite thickly covered with blackish scales indicates that this species may probably be *Ps. nigra*. Florida, type in Johnson's collection.

PSYCHODA ATERRIMA Banks.

Evidently a true *Psychoda,* as the author differentiates it from his species *Ps. nigra* because of its deeper black color, longer hair, and narrower wings. In all other respects the description is not sufficiently clear to enable one to ascertain with what species it corresponds. Ithaca, New York. The type is in Banks's collection.

PSYCHODA MINUTA Banks.

This is evidently a true *Psychoda* and, as stated above, might possibly be the species I am describing as *Ps. uniformis*. Sea Cliff, New York, and Mesilla, New Mexico. Location of type not stated (probably in Banks's collection).

PSYCHODA HORIZONTALA Haseman.

Haseman's description of the wings, male genitalia, and antennæ might apply to *Ps. cinerea*. The fact that his descriptions were drawn from two males taken on the laboratory window suggests that he was dealing with a species commonly found in buildings. (*Psychoda cinerea* is one of the common species found inside houses.)

PSYCHODA LONGIFRINGA Haseman.

This species is evidently a *Psychoda* as the author mentions "Antennæ 13-jointed; 1–2 short, stout; 3–13 each with basal enlargement . . .; terminal spike of 13 long, with perceptible enlargements; . . ." The 13-jointed antenna is not characteristic of *Psychoda,* so that probably the tip of the antenna had been broken. The "single strong clavate tentacle, sickle-shaped," might to a certain extent apply to my *Ps. interdicta*. Lake City, Florida. Location of type not stated (probably in Haseman's collection).

PSYCHODA UNIFORMATA Haseman.

As stated above, this species might be the same as the one I am describing as *Ps. interdicta* or *Ps. uniformis*. Columbia, Missouri. Type probably in the author's collection.

PSYCHODA DURIPUNCTATA Curran.

This species was made a synonym of *Brunettia albonotota* (Brun.) by Edwards (1928) after he had received Jamaican specimens, apparently from Curran and labeled *Ps. duripunctata* Curran.

PERICOMA FURCATA Kincaid.

This might be a *Psychoda* judging from the description, "antennæ 16-jointed; joints 1–2 slightly larger than the succeeding ones; joints 3–16 swollen at base." The statement "legs with alternate annulation of black and white hair" might suggest that it was *Ps. autumnalis*. Pullman, Washington. Location of type unknown.

PERICOMA TRIALBAWHORLA Haseman.

In describing this species Haseman states that nodes 8, 12, and 17 of the antennæ have whorls of snow-white hairs. This description might apply to the female antennæ of the species recognized as *Ps. autumnalis,* except that the number of segments of the antennæ in the former is said to be seventeen; *Ps. autumnalis* has sixteen. Columbia, Missouri. Location of type not given (probably in the author's collection).

PERICOMA SCALA Haseman.

The description of the antennæ is as follows: "antennæ 16-jointed; length 1.15 mm.; basal joint strong, cylindrical; second joint smaller than first, spherical; 3–15 with basal enlargement, about equal in length to the strong pedicles; 16 closely joined to 15, spherical, with short terminal spike; . . ." From the above description it is clear that the author was dealing with a *Psychoda.*

I have also found the following species described as *Psychoda* to be true *Pericoma* from examination of the specimens in the United States National Museum:[2]

[2] For differentiating the genus *Psychoda,* I have followed Tonnoir's characters of the genus, which may be briefly summarized as follows:

Psychoda.—Antennæ of fourteen to sixteen segments; segments of flagellum, except 13, having a basal spherical bulb and a long neck; these segments carrying a large cupuliform verticil of curved bristles; from segment 14 the terminal segments are quite diminutive and may be partially or completely soldered together.

Pericoma.—Antennæ usually of seventeen segments; segments of flagellum usually fusiform; last segment not diminutive and always provided with a spike.

Psychoda (*Pericoma*) *alberta* Curran.
Psychoda (*Pericoma*) *augusta* Curran.
Psychoda (*Pericoma*) *criddlei* Curran.
Psychoda (*Pericoma*) *juno* Curran.
Psychoda (*Pericoma*) *scotia* Curran.
Psychoda albitarsis Banks.
Psychoda alfaroana Banks.
Psychoda amplipenna Knab.
Psychoda busckana Dyar.
Psychoda grabhamana Dyar.
Psychoda incompleta Knab.
Psychoda interrupta Banks.
Psychoda nitida Banks.
Psychoda slossoni Williston.
Psychoda tricolor Knab.

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[3] Other references are given in the systematic discussion.

ILLUSTRATIONS

PLATE 1

FIGS. 1 to 5. *Psychoda alternata* Say; *1*, venation, male; *2*, tip of antenna, male; *3*, tip of labium (only one lobe), male; *4*, ventral plate, female; *5*, hypopygium, male.

6 to 10. *Psychoda phalænoides* (Linnæus) Tonnoir; *6*, venation, male; *7*, tip of antenna, male; *8*, tip of labium, male; *9*, ventral plate, female; *10*, hypopygium, male.

11 to 15. *Psychoda cinerea* Banks; *11*, venation, male; *12*, tip of antenna, male; *13*, tip of labium, male; *14*, ventral plate, female; *15*, hypopygium, male.

16 to 21. *Psychoda severini* Tonnoir; *16*, venation, male; *17*, tip of antenna, male; *18*, tip of labium, male; *19*, ventral plate, female; *20*, hypopygium, male; *21*, tip of antenna, female.

PLATE 2

FIGS. 1 to 5. *Psychoda pusilla* Tonnoir; *1*, venation, male; *2*, tip of antenna, male; *3*, tip of labium, male; *4*, ventral plate, female; *5*, hypopygium, male.

6 to 11. *Psychoda grisescens* Tonnoir; *6*, venation, male; *7*, tip of antenna, male; *8*, tip of labium, male; *9*, ventral plate, female; *10*, hypopygium, male; *11*, hypopygium (dorsal view), male.

12 to 16. *Psychoda interdicta* Dyar; *12*, venation, male; *13*, tip of antenna, male; *14*, tip of labium, male; *15*, ventral plate, female; *16*, hypopygium, male.

17 to 21. *Psychoda marylandana* sp. nov.; *17*, venation, male; *18*, tip of antenna, male; *19*, tip of labium, male; *20*, ventral plate, female; *21*, hypopygium, male.

22 to 25. *Psychoda uniformis* sp. nov.; *22*, venation, female; *23*, tip of labium, female; *24*, tip of antenna, female; *25*, ventral plate, female.

PLATE 3

FIGS. 1 to 4. *Psychoda sigma* Kincaid; *1*, venation, female; *2*, tip of antenna, female; *3*, tip of labium, female; *4*, ventral plate, female.

5 to 10. *Psychoda bicolor* Banks; *5*, venation, male; *6*, tip of antenna, male; *7*, paraglossa, male; *8*, ventral plate, female; *9*, spines on anal flap of ventral plate, female; *10*, hypopygium, male.

11 to 16. *Psychoda nigra* Banks; *11*, venation, male; *12*, tip of antenna, male; *13*, paraglossa, male; *14*, ventral plate, female; *15*, hypopygium, male; *16*, tip of antenna, female.

PLATE 4

FIGS. 1 to 5. *Psychoda opposita* Banks; *1*, basal segments of antenna, male; *2*, hypopygium, male; *3*, venation, male; *4*, ventral plate, female; *5*, paraglossa, male.

6 to 11. *Psychoda superba* Banks; *6*, venation, male; *7*, tip of antenna, male; *8*, hypopygium, male; *9*, paraglossa, male; *10*, tip of antenna, female; *11*, ventral plate, female.

12 to 14. *Psychoda superba* var. *conspicua* var. nov.; *12*, venation, male; *13*, hypopygium, male; *14*, tip of antenna, male.

15 to 20. *Psychoda autumnalis* Banks; *15*, tip of antenna, female; *16*, hypopygium, male; *17*, ventral plate, female; *18*, venation, male; *19*, paraglossa, male; *20*, tip of antenna, female.

PLATE 5

FIGS. 1 to 6. *Psychoda albipunctata* Williston; *1*, venation, male; *2*, tip of antenna, female; *3*, tip of antenna, male; *4*, ventral plate, female; *5*, hypopygium, male; *6*, paraglossa, male.

7 to 10. *Psychoda fumata* Knab; *7*, venation, male; *8*, hypopygium, male; *9*, tip of antenna, male; *10*, paraglossa, male.

11 to 15. *Psychoda helicis* Dyar; *11*, venation, male; *12*, ventral plate, female; *13*, tip of antenna, male; *14*, paraglossa, male; *15*, hypopygium, male.

16 to 19. *Psychoda tridactila* Kincaid; *16*, paraglossa, male; *17*, tip of antenna, male; *18*, venation, male; *19*, hypopygium, male.

PLATE 6

FIGS. 1 to 4. *Psychoda quadripunctata* Banks; *1*, venation, female; *2*, paraglossa, female; *3*, tip of antenna, female; *4*, ventral plate, female.

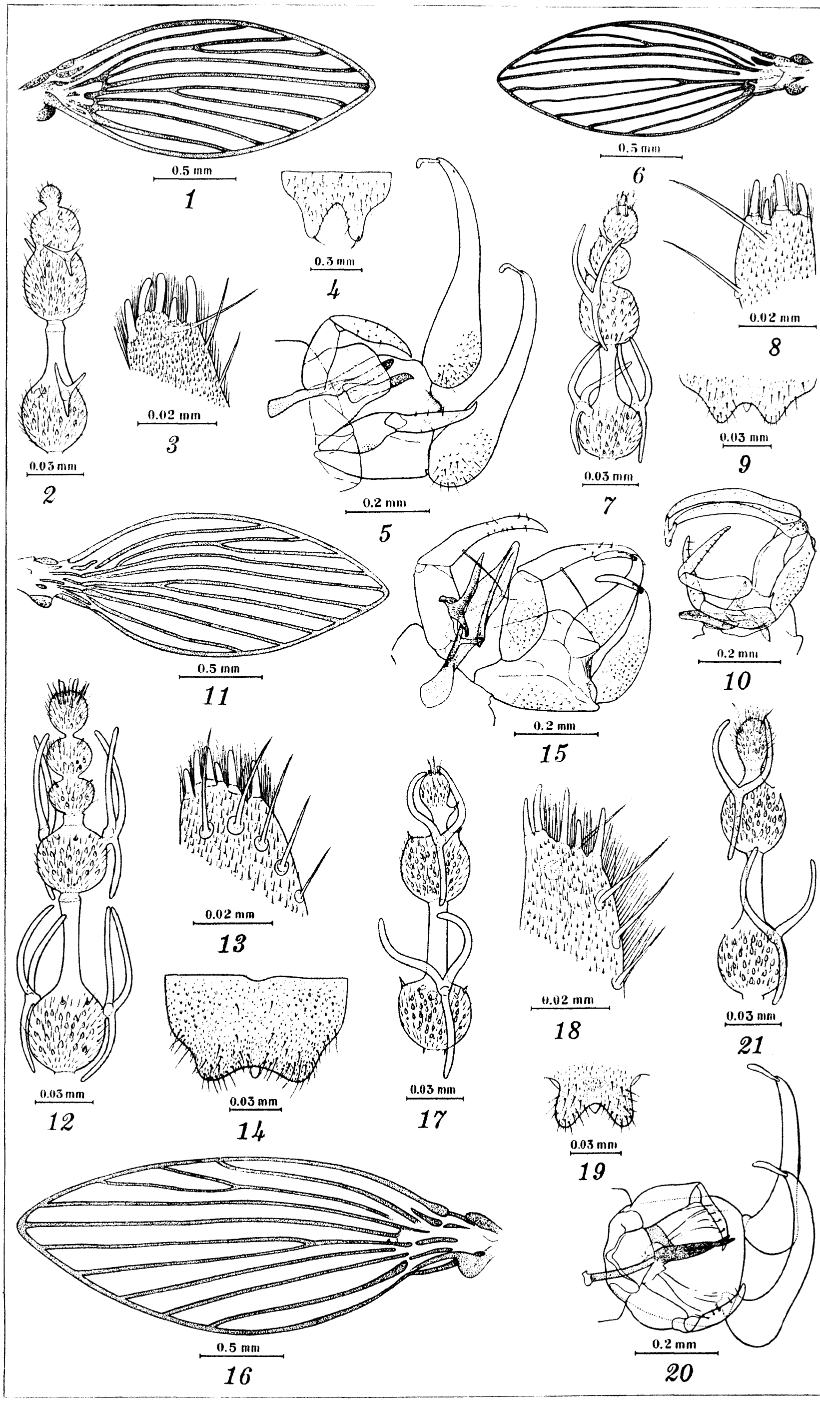
5 to 8. *Psychoda olympia* Kincaid; *5*, venation, male; *6*, tip of antenna, male; *7*, paraglossa, male; *8*, hypopygium, male.

9 to 13. *Psychoda snowhilli* sp. nov.; *9*, venation, male; *10*, tip of antenna, male; *11*, basal segments of antenna, male; *12*, paraglossa, male; *13*, hypopygium, male.

14 to 17. *Psychoda bishoppi* sp. nov.; *14*, venation, male; *15*, tip of antenna, male; *16*, paraglossa, male; *17*, hypopygium, male.

TEXT FIGURE

FIG. 1. Wing venation of *Psychoda*, showing terminology adopted for veins and cells.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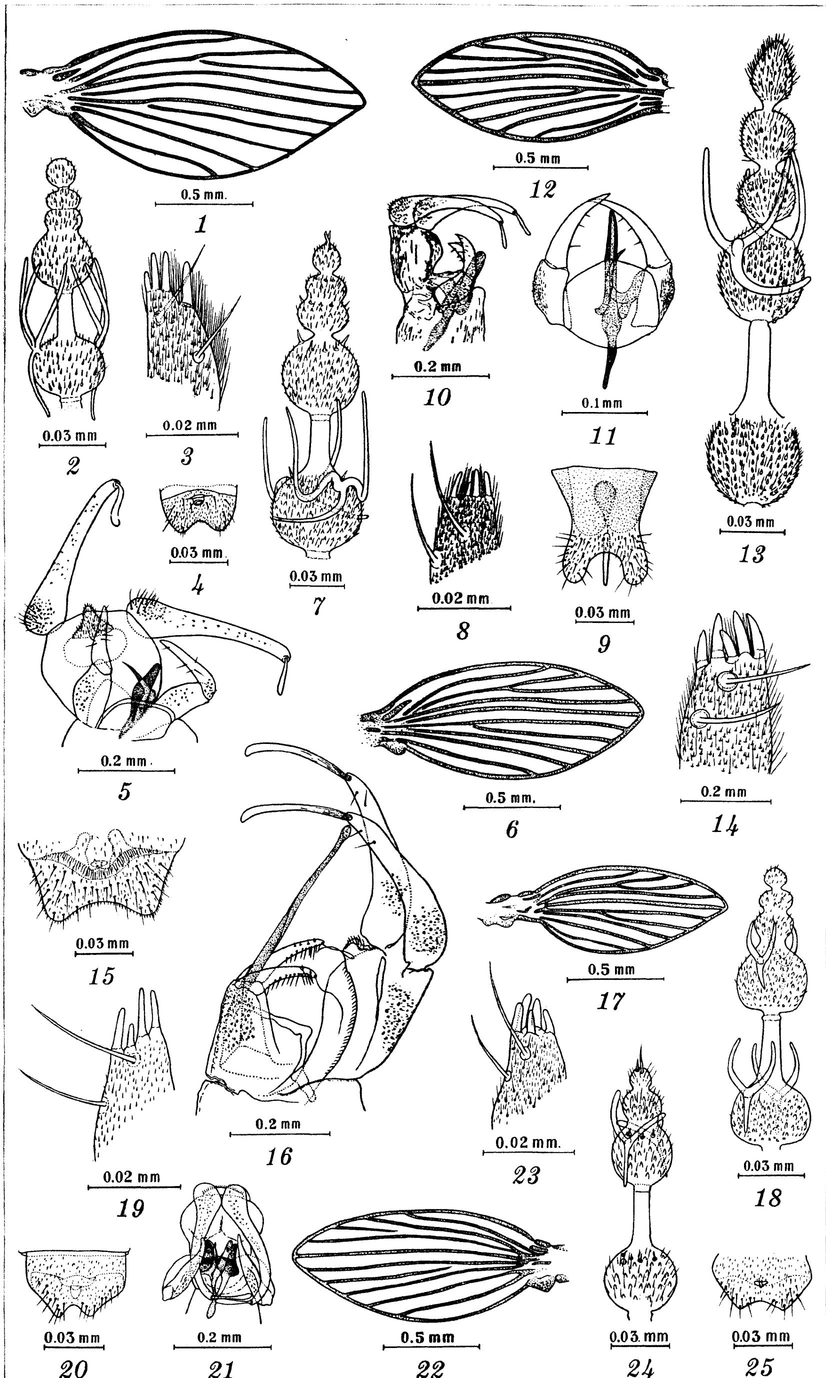
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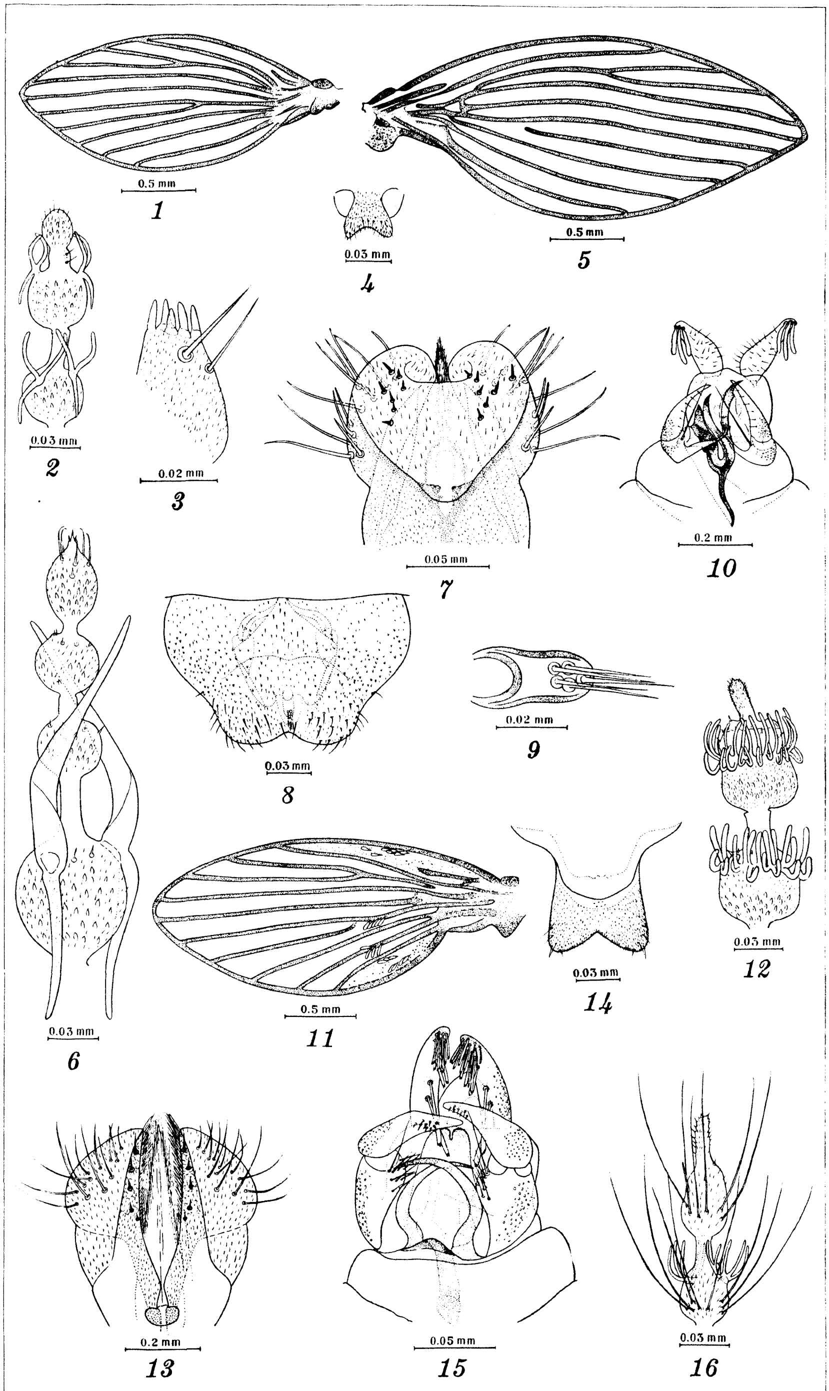
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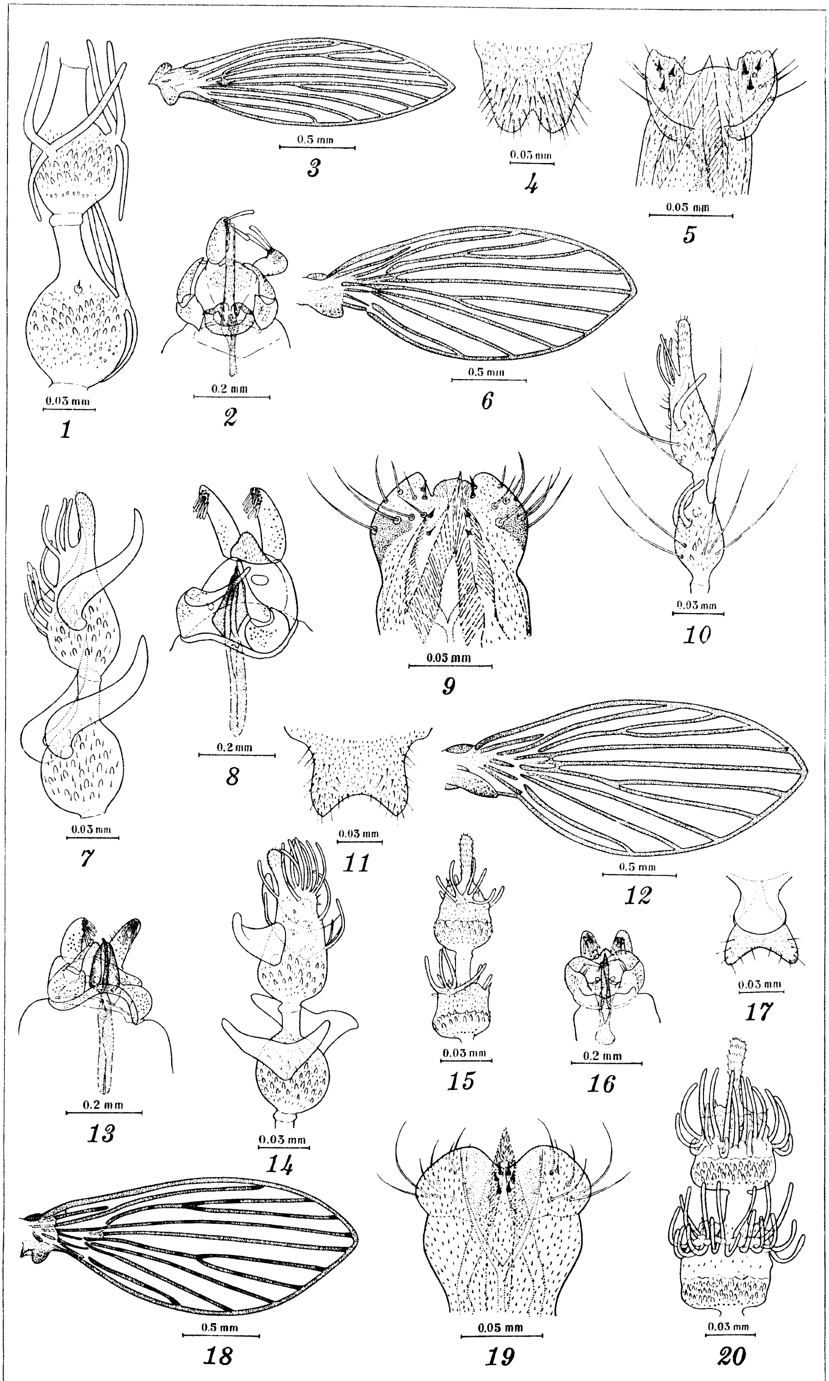
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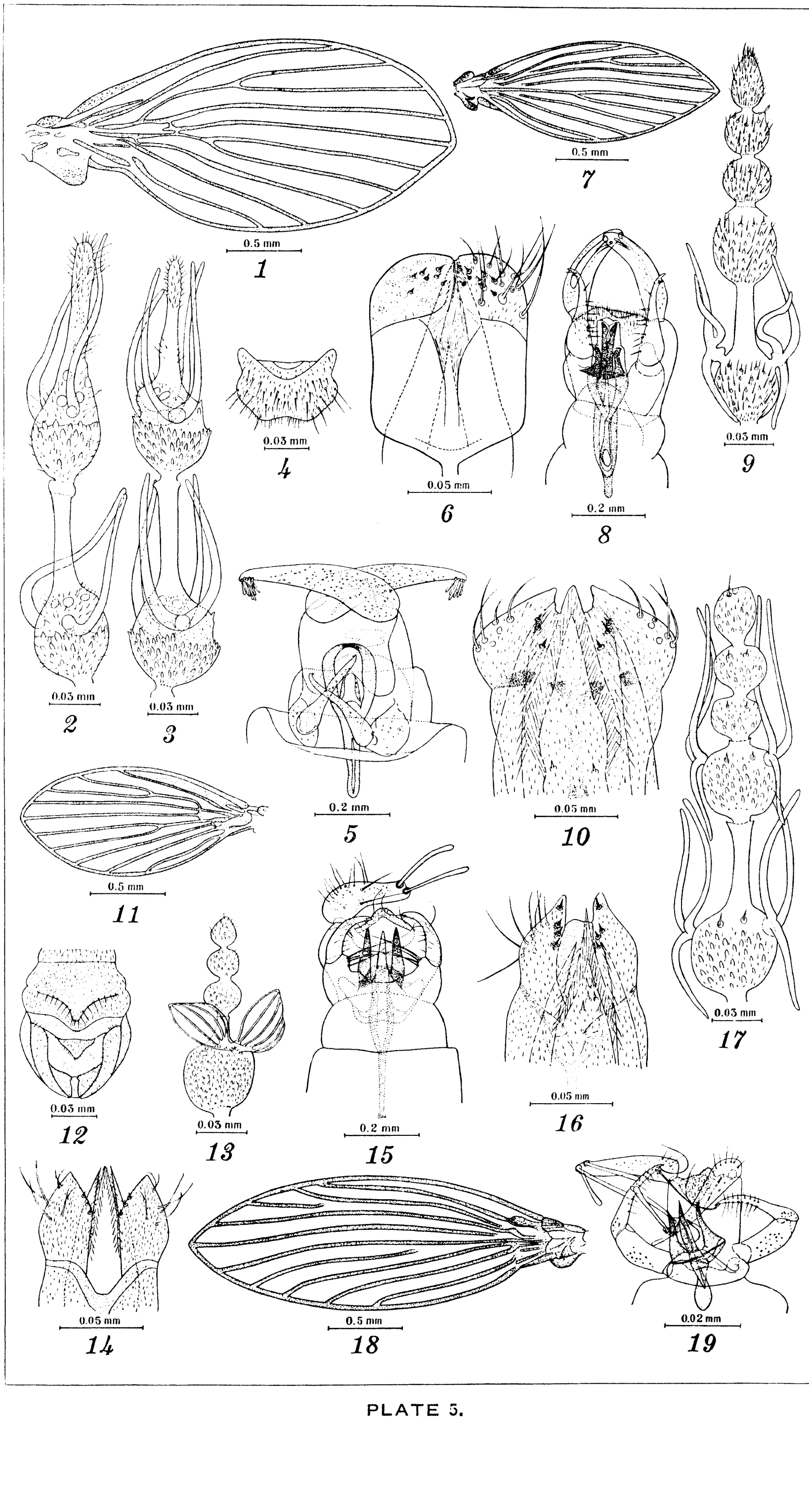
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PLATE 5.

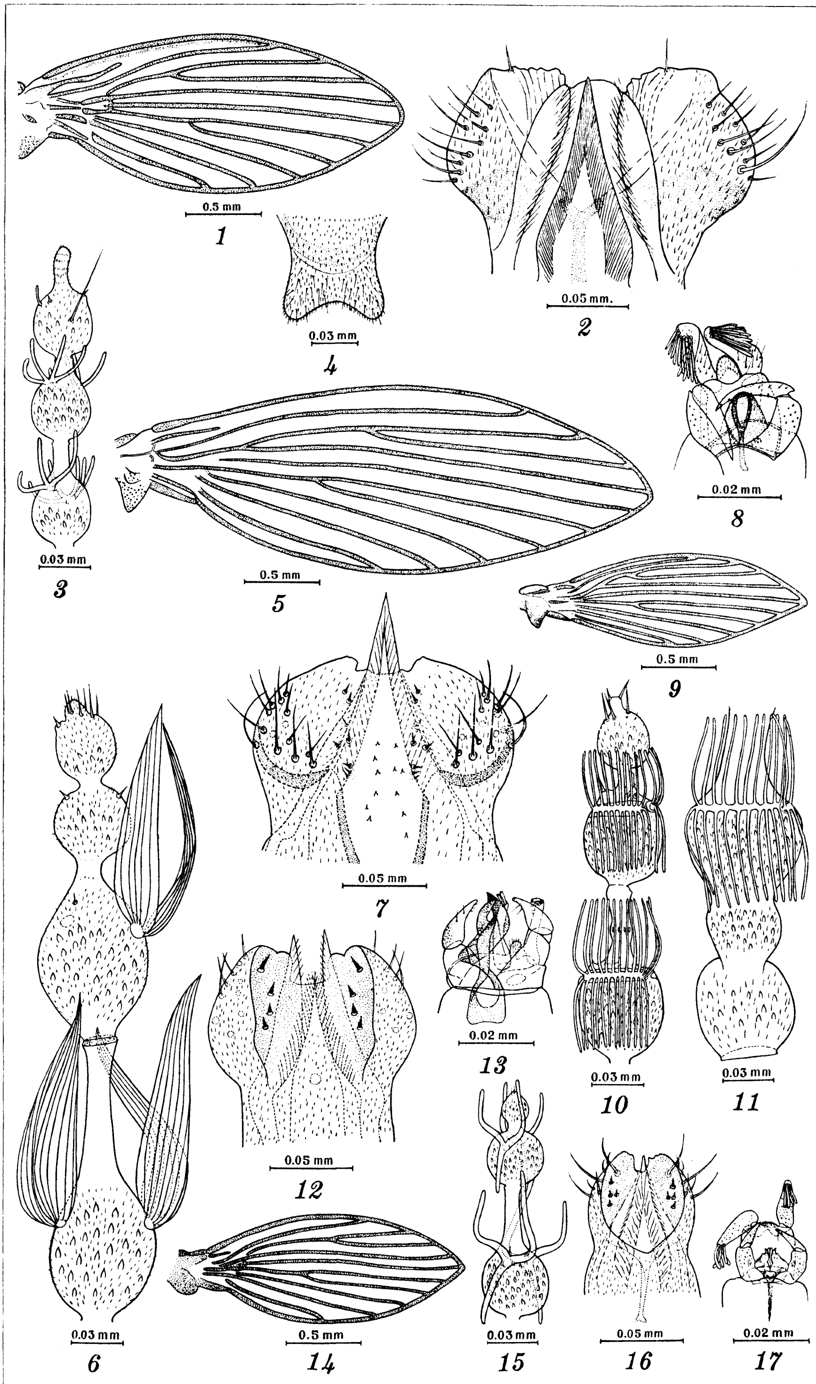
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PLATE 6.

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The articles in the Philippine Journal of Science are indexed in the International Index to Periodicals, New York, N. Y.

VOL. 59, NO. 2 FEBRUARY, 1936

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1936

298678

THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, P. I., as second-class matter.]

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 59 FEBRUARY, 1936 NO. 2

THE EFFECT OF BILE ON THE VIABILITY AND GENERAL BIOLOGY OF INTESTINAL PATHOGENIC BACTERIA

By OTTO SCHÖBL, MINORU NUKADA, and TOSHIKO KOMATSU

Of the Department of Bacteriology and Immunology, Teikoku Women's College of Medicine and Pharmacy, Omori, Tokyo

INTRODUCTION

The purpose of this investigation was mainly threefold. Being an extension of the senior author's previous experiments and experience (1, 2, 4) the present investigation was intended to elucidate some of the problems bearing on bacterial carriers.

Consequently the viability of pathogenic intestinal bacteria in bile was investigated first as the fundamental problem of the carrier state and at the same time as a practical method for the preservation of pure cultures for a long time without transplanting them.

The other main question was what changes, if any, in their biological properties, cultures of the intestinal bacteria undergo when living in bile and transplanted not by plating, but in a way that is customary in maintaining stock cultures.

DISCUSSION AND DESCRIPTION OF THE METHOD USED

The frequency with which the cholera vibrio is found in the human gall bladder at autopsy, the ease with which it is recovered therefrom, while cultures from the intestines not infrequently fail, and the observation first made by Otolenghi (3) that bile is an excellent enrichment medium for the cholera vibrio, led the senior author, years ago, to use bile for the

preservation of cholera stool specimens for delayed examination in the Tropics. During the investigation undertaken in this connection it was found that the majority of freshly isolated strains of the cholera vibrio survive in pure culture in the bile in vitro for a remarkably long time—that is, for a year or more—at room temperature in the Tropics (average 28° C.) without being transplanted. It was found that they preserve well their shape, motility, and antigenic property under such conditions. In the light of experience accumulated during a period of over ten years the author felt justified in preserving in bile cholera cultures particularly selected to be used for the preparation of vaccine and serum.(4) The unexpectedly long viability of the cholera in sea water(1) suggested the mixture of bile and salt solution for this purpose.

Although bile medium is found on a regular list of ordinary culture media, in spite of the fact that it was recommended as an enrichment medium long ago and notwithstanding the fact that it has been used in diagnosis of typhoid fever for blood culture and applied in the studies of bacterial dissociation, for instance by S. Takano,(5) comparative tests on the viability of intestinal pathogenes and the changes that may take place in their biology when transplanted "en masse," to our best knowledge, have not been carried out. Yet this question is of practical significance.

VIABILITY OF INTESTINAL PATHOGENIC BACTERIA IN BILE

THE CULTURES

The cultures used for these experiments originated from the Imperial Army Medical School, Tokyo, and were typical strains of *Bacillus coli*, *B. paratyphosus* A and B, *B. typhosus*, and *B. dysenteriæ* Shiga-Kruse, Y, and Flexner. We are greatly indebted to Col. H. Hirano for sending them to us. These strains became well known to us, since they are the same cultures that had been used in our experiments concerning the usefulness of eosin-methylene-blue glycerin agar for differentiation of intestinal bacteria.(5)

PROCEDURE

Pure cultures of these strains in peptone water were used as the seed from which test tubes containing bile in concentrations ranging from 5 per cent to 50 per cent were inoculated. The

diluent of bile was salt solution. The inoculated bile cultures were kept in the dark at room temperature. The experiment was started in July, 1933, and carried on throughout the whole year, so that the bacteria concerned were exposed to the action of bile at the various temperatures prevailing through the four seasons of the year without being transplanted.

About once a month their viability was tested by planting one or two loopfuls of the respective bile cultures into peptone water. The identity of the cultures thus obtained was assured by adding to the peptone cultures specific immune serum and observing agglutination.

From time to time the strains were tested for their biologic properties by planting them on the surface of lactose, glucose, saccharose, maltose, and mannite, eosin-methylene-blue, agar plates, placing a small loopful into each segment marked on the outside bottom of the plate.

THE RESULTS OF VIABILITY TESTS

The length of survival in bile of the intestinal bacteria under test is evident from Table 1.

It is hardly a coincidence that the intestinal bacteria which during natural infection invade the gall bladder and remain there alive for a considerable time, thus causing the carrier state, survived in bile in vitro the longest time.

Another noteworthy observation is that the concentration of bile in salt solution had little if any effect on the viability of the bacteria tested.

Since the purpose was not to search for dissociation phenomena, but to preserve the cultures in their original state as long as possible, the bile cultures were not plated out, but transferred to peptone water "en masse" as is customary in transferring stock cultures.

THE EFFECT OF TEMPERATURE ON THE SURVIVAL OF INTESTINAL BACTERIA IN BILE

As was to be expected from general experience, the factor of exposure temperature exerted considerable influence on the viability of the intestinal pathogenes in bile. The bacteria in question survived much longer at 14° C. than they did at 37° C., the time relation between the various kinds of bacteria being the same.

THE EFFECT OF CHEMICAL REACTION ON THE SURVIVAL OF INTESTINAL BACTERIA IN BILE

Three lots of 20 per cent bile in salt solution were adjusted at different pH values, 7.6, 7.2 and 6.8, placed in tubes, sterilized, planted with the strains of bacteria under test, and left at room temperature in the dark. Tests for viability were performed in the way already described, at weekly intervals.

While the temperature factor affected all cultures in the same way the various kinds of intestinal pathogenes showed, to a certain degree, a selectivity with regard to the three pH values employed.

Bacillus coli and *B. paratyphosus* B both showed a remarkable tolerance to the various degrees of acidity and survived in bile under these conditions throughout the entire test; that is, at least 93 days.

Bacillus typhosus lived in bile at pH 7.2 and 7.6 for 56 days and at pH 6.8 only 49 days.

Bacillus paratyphosus A's optimum proved to be towards the acid end inasmuch as it survived for 74 days at pH 6.8, for 93 days at pH 7.2, and only 14 days at pH 7.6.

The dysentery strains showed very low viability in bile in this case, the best being that of dysentery Y at pH 7.2. The details of this test are given in Table 2.

THE EFFECT OF BILE ON THE BIOLOGIC PROPERTIES OF INTESTINAL PATHOGENIC BACTERIA AS REVEALED BY FERMENTATION TESTS

In the course of the experiment discussed in the preceding section the cultures that had been obtained by planting the inoculated bile into peptone water from time to time were tested for their fermentative properties.

The technic mentioned in the preceding section and described on other occasions was used and the results were read in 24 and again in 48 hours. They are tabulated in Tables 3 to 7.

RESULTS OF FERMENTATION TESTS PERFORMED ON INTESTINAL BACTERIA THAT HAVE BEEN KEPT IN BILE FOR VARIOUS LENGTHS OF TIME.

On the whole the results show that the majority of the cultures tested preserved their fermentative characteristics intact for a long time. They prove that, although some of the bacterial cells in the respective cultures may have undergone a

change, the majority of them retained the characteristics of the mother culture.

One thing seems to be noteworthy in this connection; namely, the findings with regard to *B. dysenteriæ* Y (Table 3). This strain, after it had been exposed to the action of bile for seven months and shortly before it died out, apparently lost its power to ferment mannite but preserved its power to decompose glucose. Serologic tests, however, proved this strain to be a Y strain, although the fermentation tests placed it in the Shiga-Kruse class. Another phenomenon was observed in the course of these tests; namely, that the *B. coli* and *paratyphosus* strains fermented the sugars that they should, although in a rather sluggish way, towards the end of one year's exposure to bile.

As a continuation of this investigation the following experiment was carried out: Such strains from the first experiment as survived for one and one-half years in bile (*B. coli* and *B. paratyphosus* A and B) were transplanted directly from bile on eosin-methylene-blue agar plates, a small loopful having been placed on the surface of the agar without spreading it. Various carbohydrates having been added to this agar the fermentation reactions were observed. The carbohydrates were lactose, glucose, maltose, and mannite. Observations made after 24 and again 48 hours showed that none of these strains fermented maltose and some of them lost the power to ferment mannite, while the property of decomposing glucose was generally preserved as was shown by typical color reaction on the eosin-methylene-blue glucose-agar plate and by gas production in glucose agar.

The growth that appeared on the eosin-methylene-blue agar was then transplanted into peptone water and after these cultures had been incubated for 24 hours and allowed to stand at room temperature, a distinct spontaneous agglutination appeared in them, particularly strong in the case of *B. coli,* less so in the *paratyphosus* B cultures, and only slightly pronounced in the cultures of *B. paratyphosus* A. When tested after a few transplants for fermentative properties, these cultures had recovered their original power to decompose mannite, while that of splitting maltose was still impaired. On further transplanting, the spontaneous agglutination, which had been observed in the first

few transplants and which in the appearance of the sediment resembled the acid agglutination, disappeared completely.

Besides transplanting in ordinary peptone water, as already mentioned, the cultures that had been exposed to the action of bile for sixteen months, direct transplants were made from the bile cultures into peptone water containing 1 per cent maltose. After one month elapsed, during which time ten transplants in this medium had been made, all of the cultures regained completely their power to decompose maltose.

Thus it is evident from this experiment that the ability on the part of the examined cultures to decompose glucose has remained unimpaired throughout their long sojourn in bile; while their fermenting power directed against mannite, which had been lost thereby, was rapidly regained upon cultivation in plain culture media, their former ability to ferment maltose did not recover by this procedure, but did so quite readily in peptone water containing 1 per cent maltose. This statement applies to the gas producers such as *B. coli* and the paratyphosi (Tables 8 and 9).

The restoration of these important biologic properties of the intestinal bacteria under test, which they originally possessed but lost after long contact with bile, is furthermore a proof that the biologic differences between the original cultures and those recovered long after from bile are not due to accidental contamination of the bile cultures.

Simultaneously with the loss of their power to ferment certain carbohydrates the cultures in question experienced a decided shifting of their location in the zones of the metabolic spectrum on eosin-methylene-blue glycerin-agar plates. The *B. coli* strain, the number of sugars which it fermented now being less, shifted into the zone where *B. paratyphosus* normally belongs. Thus the reddish tint, which the *B. coli* group usually produces on this medium, disappeared and the growth was of a brown color, showing that also the respiration had undergone a change due to the diminished rate of multiplication.

These findings seem to indicate the explanation of the ultimate recovery of normal conditions upon subsequent transplants at frequent intervals. These, so to speak, "en masse" dissociated cultures are mixed cultures of normal and dissociated bacterial cells in which the dissociated ones by far predominate. The bacterial cells that have dissociated multiply

slower than normally, as shown by the luxuriance of growth and by shifting in the metabolic spectrum, which points to reduced respiration and possibly fermentative action and, consequently, they are soon overgrown by the cells that remained undissociated. Although originally in the minority these well-preserved bacterial cells multiply quicker than the dissociated ones, so that with repeated transplants at frequent intervals more and more of the normal cells are being transferred as a seed and the apparently dissociated culture, no plating being done but "en masse" transplants made, recovers even without the affected carbohydrate being supplied as a pabulum. This explanation seems to be the more plausible when the fact is considered that the dissociated cultures recovered more rapidly and completely when subcultivated in peptone water containing maltose than they did when grown in a plain culture medium. It is a well-known fact that bacteria grow more luxuriantly in a medium containing a carbohydrate which they decompose than in one containing a carbohydrate which they do not decompose, particularly if they possess any anaërobic tendency at all. Under the conditions of transplanting, as mentioned above, it depends, as in a contaminated culture, on the individual rapidity of growth, whether the mutant or the original type will ultimately predominate in the mixed culture.

CORRELATION OF THE APPARENT LOSS OF FERMENTATIVE PROPERTIES EVIDENCED ON EOSIN-METHYLENE-BLUE AGAR AND BY GAS PRODUCTION

In order to correlate the loss of fermentative properties of the strains concerned in the last experiment, which became apparent by the absence of the black color of growth on eosin-methylene-blue agar plates to which mannite or maltose had been added, with the actual fermentation as evidenced by gas production, and to arrive at an explanation of this phenomenon, another experiment was arranged.

As has been repeatedly demonstrated, the color reaction of the growth on the surface of this differential medium is due to at least two factors; besides the actual fermentation of the carbohydrate added to the medium, the absorption of atmospheric oxygen plays its rôle in the production of the black or brown color which appears within the mass of bacterial growth as a combination of eosin and methylene blue in the presence

of acid produced by the bacteria with the help of atmospheric oxygen.

While the strains of *B. coli* and *paratyphosus* B and A that had been kept in bile for one and one-half years were tested on eosin-methylene-blue agar plates at monthly intervals, they were simultaneously inoculated into graduated fermentation tubes containing peptone water to which glucose, maltose, and mannite, respectively, had been added. Once a month this test was repeated and curves indicating the amount of gas by days were drawn. For the sake of brevity the numerous charts obtained in this manner are omitted and the discussion of results is limited to a brief summary: Of the three gas producers *B. paratyphosus* A was the weakest. The quantitative relations between the gas produced by each of them were constant though different with each kind of bacterium. The amount of gas produced by the same strain from different sugars differed greatly, but the relation of the amount of gas produced by the same bacterium from the various sugars remained constant.

At the time when the bile cultures, more than a year old now, having been planted on eosin-methylene-blue sugar-agar plates, failed to show black growth on maltose and mannite, no striking drop in the gas production was noticed; in certain instances there was rather an increase of gas production. The only apparent change in the gas curves was a delay of the maximum of gas production for a day or two, which phenomenon signifies, as has been proven in a special experiment, that the number of viable bacteria in the bile culture has diminished by that time (Table 8).

This disagreement of results obtained by eosin-methylene-blue sugar-agar plates and those arrived at by tests for gas production places the change of the color reaction on the eosin-methylene-blue plates into the category of those phenomena which had been studied on another occasion and had been designated as shifting of bacterial respiration.

CONCLUSIONS

1. Of the intestinal pathogenic bacteria—namely, *B. coli, B. typhosus, B. paratyphosus* B and A, and *B. dysenteriæ* Shiga-Kruse, Flexner, and Y—the four first-mentioned may survive in bile diluted with salt solution for a long time, a year or more, without being transplanted; *B. dysenteriæ* only a short time, and *B. paradysentericus* somewhat longer.

TABLE 1.—*The viability of intestinal pathogenic bacteria in bile.*

[Planted June 23, 1933. Tested at monthly intervals.]

Bacterium.	Dilution of bile with salt solution.			
	25 per cent.	20 per cent.	10 per cent.	5 per cent.
Bacillus coli	12	12	12	12
Bacillus paratyphosus B	12	12	12	12
Bacillus paratyphosus A	11	12	12	12
Bacillus typhosus	11	12	7	12
Bacillus dysenteriæ Flexner	9	12	9	12
Bacillus dysenteriæ Y	5	7	5	5
Bacillus dysenteriæ Shiga-Kruse	5	5	5	5

TABLE 2.—*The viability of intestinal pathogenic bacteria in bile at different* pH *concentrations. (Room temperature.)*

Bacterium.	Days of exposure.													
	1	14	21	28	35	42	49	56	62	68	74	80	87	93
pH 7.6.														
Bacillus coli	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus B	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus A	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus typhosus	+	+	+	+	+	+	+	+	+	—	—	—	—	—
Bacillus dysenteriæ Shiga	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Flexner	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Y	+	+	+	+	+	+	+	+	+	—	—	—	—	—
pH 7.2.														
Bacillus coli	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus B	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus A	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus typhosus	+	+	+	+	+	+	+	+	+	+	+	+	—	—
Bacillus dysenteriæ Shiga	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Flexner	+	+	+	+	+	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Y	+	+	+	+	+	+	+	+	+	+	+	+	—	—
pH 6.8.														
Bacillus coli	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus B	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bacillus paratyphosus A	+	+	+	+	+	+	+	+	+	+	+	—	—	—
Bacillus typhosus	+	+	+	+	+	+	+	—	—	—	—	—	—	—
Bacillus dysenteriæ Shiga	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Flexner	+	—	—	—	—	—	—	—	—	—	—	—	—	—
Bacillus dysenteriæ Y	+	+	+	—	—	—	—	—	—	—	—	—	—	—

TABLE 3.—*Results of fermentation tests performed with cultures that had been exposed to the action of bile from June 23, 1933, until January 30, 1934; that is, for seven months.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.
	Per cent.				
Bacillus coli	5	+	+	+	+
Do	20	+	+	+	+
Do	25	+	+	+	+
Bacillus paratyphosus B	5	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus paratyphosus A	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus typhosus	5	—	+	+	+
Do	50	—	+	+	+
Bacillus dysenteriæ Flexner	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus dysenteriæ Y	20	—	+	—	—

TABLE 4.—*Results of fermentation tests performed on cultures that had been exposed to the action of bile from June 23, 1933, to May 2, 1934; that is, about nine months.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.
	Per cent.				
Bacillus paratyphosus B	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	25	—	+	+	+
Do	50	—	+	+	+
Bacillus paratyphosus A	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	25	—	+	+	+
Do	50	—	+	+	+
Bacillus typhosus	5	—	+	+	+
Bacillus dysenteriæ Flexner	20	—	+	+	+
Do	25	—	+	+	+

TABLE 5.—*Results of fermentation tests performed on cultures that had been exposed to the action of bile from June 23, 1933, to May 29, 1934; that is, about ten months.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.
	Per cent.				
Bacillus coli	5	+	+	+	+
Do	10	+	+	+	+
Do	20	+	+	+	+
Do	25	+	+	+	+
Bacillus paratyphosus B	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus paratyphosus A	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	25	—	+	+	+
Do	50	—	+	+	+
Bacillus typhosus	5	—	+	+	+
Bacillus dysenteriæ Flexner	5 and 25	—	+	+	+

TABLE 6.—*Results of fermentation tests performed on cultures that had been exposed to the action of bile from June 23, 1933, to June 28, 1934; that is, a little more than one year.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.
	Per cent.				
Bacillus coli	5	+	+	+	+
Do	10	+	+	+	+
Do	20	+	+	+	+
Bacillus paratyphosus B	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus paratyphosus A	5	—	+	+	+
Do	10	—	+	+	+
Do	20	—	+	+	+
Do	50	—	+	+	+
Bacillus typhosus	5	—	+	+	+
Bacillus dysenteriæ Flexner	20	—	+	+	+

TABLE 7.—*Results of fermentation tests performed on cultures that had been exposed to the action of bile from June 23, 1933, to September 13, 1934; that is, about fifteen months.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.	Gas production glucose.
	Per cent.					
Bacillus coli	5	+	+	—	—	+
Do	5	+	+	—	—	+
Do	5	+	+	—	—	+
Bacillus paratyphosus B	50	—	+	+	—	+
Do	50	—	+	+	—	+
Do	50	—	+	+	—	+
Bacillus paratyphosus A	5	—	+	+	—	+
Do	5	—	+	+	—	+

TABLE 8.—*Partial recovery of fermentative properties of the same cultures as given in Table 7 after the tenth transplant in peptone water. Included are the original strains that have never been in contact with bile.*

Bacterium.	Concentration of bile.	Lactose.	Glucose.	Mannite.	Maltose.	Remarks.
	Per cent.					
Bacillus coli	5	+	+	+	+	
Do	5	+	+	+	+ (?)	
Do	5	+	+	+	—	
Bacillus paratyphosus B	50	—	+	+	+	Slow.
Do	50	—	+	+	+	Slow.
Do	50	—	+	+	—	
Bacillus paratyphosus A	5	—	+	+	+	
Do	5	—	+	+	+	
ORIGINAL STRAINS.						
Bacillus coli	0	+	+	+	+	
Bacillus paratyphosus B	0	—	+	+	+	
Bacillus paratyphosus A	0	—	+	+	+	

TABLE 9.—*Complete recovery of fermentative properties toward maltose by the same cultures as given in Tables 7 and 8 after the tenth transplant in peptone water which contained 1 per cent maltose.*

Bacillus coli	1+
Do.	2+
Do.	3+
Bacillus paratyphosus B	1+
Do.	2+
Do.	3+
Bacillus paratyphosus A	1+
Do.	2+

2. There is no evidence to be gathered from our experiments that the degree of dilution of bile with salt-solution has any effect on the viability of the bacteria in bile, but the temperature of exposure and the chemical reaction of the bile affect it considerably, though not the various kinds of bacteria to the same degree.

3. After they have been kept in bile for a long time and shortly before they die out, the entire cultures undergo certain changes, which are described. These changes are of a degenerative character; they are ephemeral and easily reparable changes caused by the lowered vitality of the bacteria concerned.

TABLE 10.—*The maximum gas production at different periods of exposure to the action of bile.*

Exposure.	Lactose.	Glucose.			Maltose.			Mannite.		
	Bacillus coli.		*Bacillus parathypo-sus B.*	*Bacillus parathypo-sus A.*	*Bacillus coli.*	*Bacillus paratypho-sus B.*	*Bacillus paratypho-sus A.*	*Bacillus coli.*	*Bacillus paratypho-sus B.*	*Bacillus paratypho-sus A.*
Days.										
157	3.5	4.3	2.2	1.5	4.3	4.5	2.4	8.7	5.0	3.5
186	6.0	5.8	4.4	1.5	9.0	3.0	2.5	10.0	6.6	2.0
216	5.0	4.6	3.5	-------	5.0	6.7	-------	9.3	5.0	-------
246	4.5	4.5	5.0	-------	7.5	7.0	-------	10.0	6.6	-------

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CERTAIN FACTORS SUPPOSED TO INFLUENCE THE RESULTS OF THE TREATMENT OF LEPROSY[1]

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INTRODUCTION

There are those who claim that the results of the treatment of leprosy are influenced largely by certain factors, as age, sex, civil status, nutrition, duration of leprosy at the time of admission of the cases, and type of leprotic lesions. As far as the writer is aware, no systematic investigation has yet been conducted for the verification of these claims, except that of Wade[2] in 1923, who based his observations on the clinical improvement of the cases then being treated by several clinic physicians in Culion. He himself was conscious of the fact that the personal equation of the individual physicians affected the results of treatment as reported by them. This is probably so, because of the lack of a standard measurement of clinical improvement.

BASIS UPON WHICH THE RESULTS OF TREATMENT WERE JUDGED

In order to avoid the objections to the use of clinical improvement as the basis for judging the results of the treatment, it is necessary to adopt some other kind of standard measurement of improvement. There is probably no better one, from the points of view of uniformity and of practicability, than the proportion of cases that have been paroled as a result of the treatment.

In the Philippines only the bacteriologically positive cases are by law required to be segregated. In order to determine whether a case is positive or not, smears are taken from the skin and the nasal mucosa, and none from the lymph nodes and nerves. When a case has become improved to such an extent that he no longer shows *M. lepræ* in smears taken from the skin and nasal mucosa, he is considered to be in the period of quiescence, and after one year of further observation (with regular

[1] Published with the approval of the Director of Health.

[2] Wade, H. W., Journ. Philip. Is. Med. Assoc. 3 No. 5 (1923).

periodic examination), provided that he has never subsequently been found positive bacteriologically, he is discharged from segregation and is placed under parole as an arrested case. For the purpose of this paper, the details regarding the parole system need not be gone into, but it suffices to say that the result of the treatment can best be judged by the proportion of paroled cases in each of the different groups studied, without taking into consideration the permanency of the apparent cure obtained from the treatment.

MATERIAL FOR STUDY

For the purpose of ascertaining how much, if at all, each of the factors mentioned above affects the results of treatment, the records of the patients admitted to the Eversley Childs Treatment Station from 1929 to 1933, inclusive, were reviewed. Excluding readmissions (relapsed paroled cases, returned absconders, and those retransferred from Culion and other stations), there were 1,235 new admissions during that period. Of these, 788 either were sent to the Culion Leper Colony, had died, or had absconded, leaving only 477 cases who were treated in this station up to May, 1935, or until paroled. These patients, it may be mentioned in passing, were treated almost entirely with *Hydnocarpus wightiana* oil, or its ethyl esters, either iodized or creosoted. Only very few were, for some time, placed under special treatments in experiments with new medicines. These 447 patients constitute the material for this study.

CLASSIFICATION OF CASES AND ITS RELATION TO THE RESULT OF TREATMENT

According to the classification of leprosy proposed by the Leonard Wood Memorial Conference on Leprosy held in Manila in 1931, there are two main types; namely, the neural (N) and the cutaneous (C). In addition the following subtypes of the above main types, indicating the degree of severity, were recognized:

Neural.	Cutaneous.
N-1. Slight neural.	C-1. Slight cutaneous.
N-2. Moderately advanced neural.	C-2. Moderately advanced cutaneous.
N-3. Advanced neural.	C-3. Advanced cutaneous.

The report of this conference further states: "In all cutaneous types there may be varying degrees of neural involvement and

such cases should be recorded to indicate the degree of this involvement; as for example, C–2, N–1." However, in this paper only the cutaneous lesions are considered; the concomitant neural manifestations were disregarded.

TABLE 1.—*Relation of the types of leprosy (cutaneous only) to the results of treatment.*

Type.	Cases treated.	Cases paroled.	Per cent.
C–1	126	70	55.55
C–2	191	68	35.39
C–3	130	30	23.08

Table 1 shows that the amenability of leprosy to treatment is inversely proportional to the severity of the skin lesions. The reason for this is so obvious that it needs no further comment. However, it is also observed that some cases of the severer types have been paroled even earlier than some of the milder ones, which goes to show that, besides the severity of skin lesions, there must be other contributory factors that influence the results of the treatment.

RELATION OF THE DURATION OF LEPROSY ON ADMISSION TO THE RESULT OF TREATMENT

The duration of leprosy in each case was taken from the information given by the patient. (It is the period from the time the patient himself notices signs or symptoms of leprosy to the time of admission.) It is possible that all cases were infected in their early childhood as claimed by Manalang,[3] and that the disease has remained latent or in an atypical form until adult age or late in life as claimed by Chiyuto,[4] and these early manifestations were either not suspected of being those of leprosy or were entirely overlooked by the patient until frank lesions and symptoms developed. It is probable, therefore, that the real onset in most, or probably in all, of the cases had occurred much earlier, and that the duration was in reality much longer than that given by the patients. In view of the impossibility of determining the exact duration in each and every case, the

[3] Manalang, C., Monthly Bull. Philip. Health Service 12 (1932) 363.

[4] Chiyuto, S., Monthly Bull. Bureau of Health, Manila (January, 1933) 5–48.

duration given by the patients was considered more practical and sufficient for the purposes of this paper.

TABLE 2.—*Relation of the duration of leprosy on admission to the results of treatment.*

Duration.	Cases treated.	Cases paroled.	Per cent.
Less than 1 year	82	32	39.02
From 1 to 2 years	146	54	36.58
From 2 to 3 years	80	30	37.50
From 3 to 4 years	58	22	37.93
From 4 to 5 years	28	11	39.29
From 5 to 6 years	29	10	34.48
From 6 to 7 years	3	1	33.33
From 7 to 8 years	2	0	0.00
From 8 to 9 years	4	3	75.00
From 9 to 10 years	2	0	0.00
10 years and over	13	5	38.45

The proportion of paroled cases as shown in Table 2 is about the same in the different periods of duration given, except in those ranging from 6 to 10 years, where there were too few patients recorded. In other words, the results of the treatment is practically the same, irrespective of the duration of the disease as furnished by the patients. The explanation for this rather surprising finding is that the progress of the disease varies greatly in different individuals, and that while in some cases it may develop to an advanced stage within a year, in others it remains stationary or latent for a long time, so that there is no fixed relationship between duration and the skin subtypes.

THE RELATION OF AGE ON ADMISSION TO THE RESULTS OF TREATMENT

The relation of age to the results of treatment has been dealt with by many authorities. Wade[5] observed "that young people up to 20 years of age are increasingly amenable to treatment as they approach maturity, but from 20 to 30, during the period when sexual activity is at its height, the improvement rate falls off." He observed further that "the next decade is one of less activity and greater improvement for both sexes, but in the fifth decade, in which the males retain the improved rate, the females, who are disturbed by menopause, show a marked drop."

[5] Loc. cit.

A similar observation was recorded by Rogers and Muir [6] who stated that "after the age of thirty most people have formed regular, steady habits, and on the whole the prognosis becomes more and more favourable after the age of forty." On the other hand, they claimed that "the vitality of youth, when it can be wisely curbed, is a powerful factor towards recovery."

More recently a controversy arose regarding the amenability to treatment of leprosy found in children. Rose [7] claims that "cases treated in early childhood, moreover, yield more readily to treatment than the adult," while Christian [8] claims that "In children leprosy treatment does not give such quick results as in adults, but when they reach adult age they improve and clear up rapidly under treatment."

TABLE 3.—*Relation of age on admission to the results of treatment.*

Age on admission.	Cases treated.	Cases paroled.	Per cent.
From 1 to 10 years	56	23	41.07
From 11 to 20 years	161	55	34.16
From 21 to 30 years	109	32	29.57
From 31 to 40 years	59	26	44.07
From 41 to 50 years	36	21	58.33
From 51 to 60 years	13	6	46.15
Over 60 years	13	5	38.46

Data regarding this point appear in Table 3. The results of the treatment in the above table, judged from the percentage of paroled cases, give a curve which goes down from the first to the third decade from where it goes up to the fifth, and thence goes down again. It appears then that the age on admission bears a certain definite relationship to the results of treatment.

The claim that the periods of puberty and childbirth have a bad effect on the prognosis of leprosy is apparently supported by these findings. Puberty occurs in the second decade, and the most productive childbearing period is in the third, and it is in these two decades that the results of treatment are poorest.

[6] Rogers, L., and E. Muir, Leprosy. New York. Wm. Wood & Co. (1925).

[7] Rose, F. G., Leprosy Review 4 No. 4 (1934).

[8] Christian, E. B., Efficiency of institutional treatment of leprosy. Leprosy in India 6 No. 4 (October, 1934).

But it will be seen later in Table 6 that these two factors were not entirely responsible for the poor results in these two decades, for they did not even appear to be important factors in the treatment of these cases.

One reason why the results of treatment are poor in these two decades may be the fact that it is not until a patient passes the age of 30 that he begins to lead a regular life with steady habits, becomes serious about his treatment, and acquires a great determination to get well. It is also in the second and third decades that one is apt to indulge in the excesses and abuses of youth. After 50 the results of treatment go down steadily, probably because it is from this age that the recuperative powers of the body gradually decline.

Whether or not cases in early childhood yield more readily to treatment than adult cases cannot be determined with the available data in this study for the reason that there was only one case in early childhood, or below 5 years of age, admitted from 1929 to 1933. This case was paroled. If childhood as a whole is considered, those admitted in the first decade of life may be taken as cases of that period. The results obtained in this group are equal to the average of the percentages of the different age groups. It is better than the results obtained in the second and third decades and above the sixth, but poorer than those in the fourth, fifth, and sixth.

The results recorded in Table 3 suggest the possibility that there are comparatively few advanced cases in the decades showing good results and more of them in those with poor results. However, Table 4 shows that this is not the case.

TABLE 4.—*Proportion of the types of cutaneous lesions in the second, third, and fifth decades.*

Age on admission.	C-1.	Per cent.	C-2.	Per cent.	C-3.	Per cent.
From 11 to 20 years	50	31.06	66	40.99	45	27.95
From 21 to 30 years	26	23.85	46	42.21	37	33.94
From 41 to 50 years	8	22.22	19	52.78	9	25.00

In Table 4 the proportion of the types of skin lesions in the third decade where the result of treatment is poorest was compared with that of the fifth decade where the result is best, taking the second decade where the result is halfway between as a control. It can be seen that while it is true that the fifth decade had the smallest proportion of C-3 cases, it had likewise

the lowest percentage of C–1 cases, which compensates for this apparent advantage. Hence, while it has already been shown that the advancement of skin lesions has some influence on the result of the treatment, it cannot be said that it is a deciding factor in determining the results of treatment in relation to age.

Further proof that age has an inherent influence independent of the advancement of the skin lesions is given in Table 5. Here it is shown that the percentage of paroles is highest in the fifth decade in all the cutaneous subtypes, compared with the two other decades under discussion.

TABLE 5.—*Percentage of paroled cases in each of the different types of skin lesions under the second, third, and fifth decades.*

Age group.	C–1.	Paroled.	Per cent.	C–2.	Paroled.	Per cent.	C–3.	Paroled.	Per cent.
From 11 to 20 years	50	23	46.00	66	22	33.33	45	10	22.22
From 21 to 30 years	26	15	57.69	46	10	21.74	37	7	18.81
From 41 to 50 years	8	6	75.00	19	10	52.63	9	5	55.55

RELATION OF SEX TO THE RESULTS OF TREATMENT

It has already been stated that the poor results of the treatment in the second and third decades of life may be due to the effects of puberty and childbirth. This will be better demonstrated by considering the two sexes separately.

The figures in Table 6 do not substantiate this contention. It may be possible that puberty was partly responsible for the percentage of paroles in the second decade, but it is not likely the main cause of it, for if this were the case, it should have affected more the females who manifest a depressed physiological state, some of whom actually become ill during puberty and at every menstruation which has no counterpart in the males. On the contrary, the percentage is much lower among the males than among the females in the second decade.

The low percentage of paroles in the third decade may be attributed to childbirth, but again this is not likely the case, for it would have affected the females only. As shown in Table 6, the percentage of paroles is much lower among the males than among the females. Hence, childbirth does not seem to have played an important rôle in determining the result of the treatment among these cases.

In view of the foregoing considerations, one is inclined to believe that some other factors, probably still undetermined, were responsible for these poor results of treatment in the two decades under consideration. Wade [9] says that these decades are the period when sexual activity is at its height, and he seems to attribute the poor results of treatment at this stage of life to this fact. At any rate, contrary to what is commonly claimed, puberty and childbirth do not seem to be important factors in the treatment, at least among these cases.

Wade observed that the improvement rates of different age groups and those for the different duration groups, plotted separately, will show that the females have for the most part a higher improvement rate than the males. In the fifth decade the females, who are disturbed by the menopause, show a marked drop, while the males show a good rate of improvement.

TABLE 6.—*Age and sex distribution of cases treated and paroled.*

Age group.	Males.			Females.		
	Treated.	Paroled.	Per cent.	Treated.	Paroled.	Per cent.
From 1 to 10 years	32	13	40.63	24	10	41.66
From 11 to 20 years	84	27	32.14	77	28	36.36
From 21 to 30 years	74	19	25.68	35	13	37.14
From 31 to 40 years	45	16	35.55	14	10	71.43
From 41 to 50 years	23	15	65.22	13	6	46.16
From 51 to 60 years	5	0	0.00	8	6	75.00
Over 61 years	11	4	36.36	2	1	50.00
Total	274	94	34.31	173	74	42.77

Table 6 apparently supports the observation of Wade based on the clinical improvement of cases under treatment. In all the different age groups (except the fifth decade) the females have a higher percentage of paroled cases than the males.

Are the female cases more amenable to treatment simply because of their sex, or is it because there are more of the less-advanced cases among them, or is leprosy more apt to develop in the female sex in those periods of life found to be favorable to treatment?

It appears in Table 7 that there were actually less of the advanced cases among females than among males. However, the difference is not marked enough to influence the difference in the proportion of paroled cases in the two sexes.

[9] Journ. Philip. Is. Med. Assoc. 3 No. 5 (1923).

TABLE 7.—*Proportion of the types of skin lesions in males and females.*

Sex.	Total.	C-1.	Per cent.	C-2.	Per cent.	C-3.	Per cent.
Males	274	78	28.47	111	40.51	85	31.02
Females	173	50	28.90	76	43.93	47	27.17

On the other hand, the favorable influence of age does not seem to contribute anything towards the good results obtained in the females (see Table 8).

TABLE 8.—*Proportion of the different age groups in males and females.*

Age group.	Males.	Per cent.	Females.	Per cent.
From 1 to 10 years	32	11.68	24	13.87
From 11 to 20 years	84	30.65	77	44.51
From 21 to 30 years	74	27.00	35	20.23
From 31 to 40 years	45	16.42	14	7.59
From 41 to 50 years	23	8.39	13	7.01
From 51 to 60 years	5	1.83	8	4.62
Over 61 years	11	4.01	2	2.31

It was found in Table 3 that the first, fourth, fifth, and sixth decades gave better results than the second, and third, and beyond the sixth decades. In Table 8, if the first, fourth, fifth, and sixth decades are put together, it will be found that the males had 38.32 per cent of all their cases under these more-favorable age groups, while the females had only 33.09 per cent in these groups. Therefore, it may be said that age alone was not responsible for the favorable response to the treatment obtained among the females; on the contrary, this fact apparently placed the females at a disadvantage.

From the foregoing considerations it seems probable that sex per se has an influence on treatment independent of the other factors that have already been considered. The favorable results among the female lepers may be explained, in part, by the fact that the females are, as a rule, better patients, comply more strictly with instructions, are more serious in their treatments, and are less addicted to abuses than the males. Apparently these traits of the females more than offset the detrimental effects of childbirth and menopause.

RELATION OF THE CIVIL STATUS TO THE RESULTS OF TREATMENT

It was found in this investigation that those who were widowed showed better results under the treatment than the unmarried and married patients.

TABLE 9.—*Relation of civil status to the result of treatment.*

Civil status.	Cases treated.	Cases paroled.	Per cent.
Children [a]	93	34	36.56
Single	164	60	36.88
Married	166	59	36.58
Widowed	24	15	62.50

[a] Children up to 13 years old. It was thought proper to separate them in order not to influence the unmarried cases with whatever effect they may have.

In Table 9 the children, the unmarried, and the married cases show about the same results, while the widowed cases have a higher percentage of paroles. This may be partly due to the small percentage of advanced cases among the widowed, as is shown in Table 10.

TABLE 10.—*Comparison of the proportion of the types of skin lesions in the widowed cases with that of the entire group of patients.*

Group.	C–1.	Per cent.	C–2.	Per cent.	C–3.	Per cent.
Entire	126	27.88	191	42.70	130	29.42
Widowed	8	33.34	11	45.83	5	20.88

There were higher percentages of C–1 and C–2 cases, and a lower percentage of C–3 cases in the widowed patients than in the rest of the group treated.

Another contributory factor found to favor the effect of treatment in the widowed group is the fact that 66.67 per cent of the widowed cases (see Table 11) were in the fourth, fifth, and sixth decades, which were found in Table 3 to have high percentages of paroled cases.

TABLE 11.—*Comparison of the proportion of the different age groups in the widowed cases with that of the entire group of patients.*

Age group.	Cases treated.	Per cent.	Widowed cases.	Per cent.
From 1 to 10 years	56	12.51	0	0.00
From 11 to 20 years	161	36.03	1	4.16
From 21 to 30 years	109	24.39	4	16.67
From 31 to 40 years	59	13.20	4	16.67
From 41 to 50 years	36	8.05	6	25.00
From 51 to 60 years	13	2.91	6	25.00
Over 61 years	13	2.91	3	12.50

There were also fourteen females among the twenty-four widowed patients, or 58.33 per cent, and since females have a higher percentage of paroled cases than the males, this fact may also contribute to the good results found in the widowed cases.

The conclusion, therefore, is that the widowed cases herein studied showed favorable results under the treatment, because of the facts (*a*) that they were generally of mature age, (*b*) that there were more females than males among them, and (*c*) that they had a greater proportion of the slightly and moderately advanced cases and less of the advanced cases than the other groups of patients.

However, the widowed patients constituted only 5.37 per cent of the entire group, so that civil status did not seem to play an important rôle in influencing the results of the treatment of the whole group.

RELATION OF ROBUSTNESS TO THE RESULTS OF TREATMENT

For the purposes of this investigation, the state of nutrition was not determined on the basis of the height-weight ratio, but on the degree of robustness judged solely by inspection. The cases were classified into three groups: (*a*) The thin or under-nourished, (*b*) the normal or well-nourished, and (*c*) the obese or over-nourished. When some difficulty was experienced in deciding whether a patient was thin or obese, the case was classified as normal or well-nourished.

TABLE 12.—*Relation of robustness to the result of treatment.*

Degree of nutrition.	Cases treated.	Cases paroled.	Per cent.
Thin	71	33	46.48
Normal	348	129	37.07
Obese	28	6	21.43

Table 12 shows that there were too few of the obese and thin patients to warrant definite conclusions. However, the difference in the results obtained in the different degrees of robustness is so striking that it cannot escape attention. The results of treatment may be considered, in view of these findings, to have a definite relation to the degree of nutrition. Contrary to what was expected, the obese showed the poorest results, while the thin cases gave the best. These findings are in agreement,

however, with the frequent observation in this station that when a patient gains weight rapidly, his leprosy becomes either stationary or worse, even if he had been improving previously. The thin persons are generally observed to fare well under the treatment, provided their thinness is not due to complicating diseases.

To eliminate the possibility that the favorable effects shown among the thin individuals may be due to the preponderance of less-advanced cases among them, Table 13 was prepared.

TABLE 13.—*Proportion of the subtypes of skin lesions in the three different degrees of nutrition.*

Degree of nutrition.	C-1.	Per cent.	C-2.	Per cent.	C-3.	Per cent.
Thin	41	58.30	21	29.86	9	11.84
Normal	71	20.40	160	46.00	117	33.60
Obese	14	50.00	10	35.71	4	14.29

Table 13 shows that the proportion of less-advanced and well-advanced cases was about the same in the thin as in the obese groups, and for this reason the proportion of the different types of skin lesions may have had nothing to do with the result of the treatment found in relation to the degree of nutrition.

There were twenty-five cases, or 35.21 per cent, under the age groups found favorable to treatment in Table 3 among the thin cases compared with eleven cases, or 39.28 per cent, in the obese. Since these figures are practically the same, it may also be inferred that the favorable influence of age did not affect the results obtained under the consideration of nutrition.

There were twenty-nine females, or 40.57 per cent, among the thin, and nine females, or 32.14 per cent, among the obese. This slight advantage in favor of the thin patients alone cannot explain the difference in the percentage of paroled cases observed between the two groups.

Although the data here presented cannot be considered conclusive, it appears that the excess of fat in the body is an unfavorable element in the treatment of leprosy.

SUMMARY AND CONCLUSIONS

1. The effect of certain factors supposed to influence the results of treatment has been studied.

2. The severity of skin lesions was found inversely proportional to the percentage of paroled cases.

3. The duration of the disease was found to have apparently no relation to the results of treatment.

4. The age on admission was found to have a definite relation to the results of the treatment, in that the first, fourth, fifth, and sixth decades gave higher percentages of paroled cases than the other decades. The results, if plotted with age, gave a curve that goes down from the first to the third as the lowest point, gradually rising to the fifth decade as the highest point from which it goes down again.

5. The results of the treatment were found to be apparently better among the females than among the males, except in the fifth decade, probably due to the menopause which disturbs the physiological life of the females.

6. Contrary to what is commonly claimed, puberty and childbirth did not seem to be important factors in the treatment among these cases.

7. The results of treatment were found to be good among the widowed patients, but this is due to the fact that they are generally of mature age and, in the groups studied, there were more females and more of the less-advanced cases than among the unmarried and married cases.

8. The degree of nutrition was found to have a definite relation to the results of treatment. The results are inversely proportional to the degree of obesity of the patients. It appears that excess fat in the body has an unfavorable effect on the treatment of leprosy.

THE LETHAL EFFECT OF HOMOZYGOUS PURPLE AND EYELESS GENES IN DROSOPHILA

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INTRODUCTION

In both plants and animals there are genetic factors which cause not only certain morphological changes, but also the nondevelopment or nonfunctioning of certain vital organs, thus causing the death of individuals affected. These are known as "lethal factors." These factors may cause an early or late death of the organism affected, depending upon the nature of the effect. Thus Castle and Little's (5) homozygous yellow mouse dies in the early embryonic stage, while Detlefsen (8) reported a case of a lethal factor, also in the mouse, which allows the individuals affected to live only for a few days after birth.

In all cases of zygotic lethal factors thus far reported, the death of an organism has been found to be due to a single gene. This gene causes the death of the individual only when it is in a homozygous condition. When the individual is heterozygous, the effect of the gene is not fatal. This is true whether the lethal factor is dominant or recessive. Examples of dominant factors which are lethal when homozygous are the factors for the yellow mouse of Castle and Little, (5) for dominant spotting in the mouse of Little, (12) for star eye, streak thorax pattern, and confluent veins in the *Drosophila* of Bridges as reported by Bridges and Morgan, (2) and for beaded wing in the *Drosophila* of Morgan as reported by Bridges and Morgan. (3) Examples of recessive factors that are lethal when homozygous are the factors for abortive gametes in the velvet bean of Belling, (1) for the albino corn of Jones, (11) for the truncate wing in the *Drosophila* of Morgan, (14) and for the "stickiness," or extreme softening of the bones, in the domestic fowl of Byerly and Jull. (4)

Lethal factors may be found in the sex chromosome and are known as sex-linked lethals, or they may be found in the autosomes and are known as autosomal lethals. In *Drosophila*

the sex-linked lethals are numbered l–I_1, l–I_2, l–I_3, etc., while the autosomal lethals are numbered l–II_a, l–II_b, l–II_c, etc., for the second chromosome, and l–III_a, l–III_b, l–III_c, etc., for the third chromosome. Sex-linked lethals are often the cause of the disturbance of the sex ratio in animals, as shown by the works of Rawls,(18) Morgan,(15) and Stark(19) in *Drosophila.* Autosomal lethals on the other hand affect both sexes equally and, therefore, do not cause any disturbance in the sex ratio. They, however, cause a deviation in the expected Mendelian ratios. Cases of autosomal lethals are illustrated by the work of Little(13) in the mouse, Jones(11) in the cat, Dunn(9) in fowls, Bridges and Morgan(2, 3) in *Drosophila,* Jones(11) in corn, and Belling(1) in the velvet bean.

Müller(17) reported cases of "balanced lethals" in *Drosophila* in which two linked lethal factors may be present and yet may not cause the death of the animal. This is due to the fact that neither is found in homozygous condition.

In this paper a new case in *Drosophila* is reported, in which two autosomal recessive factors that are found in different chromosomes act as lethal factors when brought together in homozygous condition, but are nonlethal when present alone. These factors are *eyeless,* a fourth chromosome mutation, which is recessive to eyed condition; and *purple eye,* a second chromosome mutation, which is recessive to red eye.

The author is indebted to Mr. Juan B. Ortega and Mr. Jose V. Yap Chiongco for helping him make these experiments.

MATERIALS AND METHODS

Two kinds of pure stock flies were used in these experiments. These were eyeless and purple, which were both obtained as mutations from the Bandless Manila Wild flies. The eyeless mutant was found June 22, 1926, and since then had been breeding true. Eyeless flies possess small heads due to the total or partial elimination of the compound eyes. Likewise, the ocelli are totally absent. Whenever a portion of the compound eyes is present, the color is red, showing that the eyeless mutant is a carrier of the red color factor. This is further substantiated in our cross between eyeless and purple stock which always results in the production of red-eyed offspring. Genetic tests of eyeless by Clemente(6) show that it behaves as a simple Mendelian recessive to eyed condition. According to Morgan, Sturtevant, Müller, and Bridges(16) this is a mutation of the fourth chromosome.

The purple-eyed mutation was found August 26, 1926, and until now is breeding true. This mutation affects the eye color, the shade of which changes with age. It is lighter in young flies and darker in old ones. The true purple shade develops when the adult flies are about a day or two old. Genetic tests with the wild flies show that purple behaves as a simple Mendelian recessive to its allelomorph red eye. According to Bridges and Morgan (2) this is a mutation of the second chromosome.

By a comparative study of their duration of life Clemente (7) has shown that eyeless and purple-eyed flies are practically the same in viability. Eyeless flies, however, are not as active as purple flies, due perhaps to the absence of eyes.

The food consisted of a well-stirred sliced ripe banana sprinkled with powdered yeast foam tablets. The breeding containers used were 8-drachm homœopathic vials for test matings and 120-cc bottles for stock cultures. All cultures were kept in a Frigidaire at a more or less constant temperature of 25° C.

Numerous types of matings were made, but special emphasis was given to those matings which would help prove that the flies that are homozygous for both purple and eyeless do not exist at all. In most cases reciprocal matings were made in order to obtain better results.

EXPERIMENTAL RESULTS AND DISCUSSIONS

CROSSING OF EYELESS TO PURPLE

About 10 virgin eyeless females were mated to 10 purple-eyed males. This mating produced 118 red-eyed F_1 offspring of which 53 were males and 65 were females (Table 1). A reciprocal mating was made in which the females were purple and the males eyeless. This gave 833 red-eyed F_1 offspring of which 429 were males and 404 were females. The total for the two reciprocal crosses was 951 flies of which 482 were males and 469 were females.

TABLE 1.—*F_1 offspring obtained by mating eyeless × purple.*

Type of mating.	Red-eyed.		Total.
	Males.	Females.	
Eyeless female × purple-eyed male	53	65	118
Purple-eyed female × eyeless male	429	404	833
Total	482	469	951

The results obtained in the above matings were to be expected if it is assumed that the eyeless parent, in addition to carrying the recessive eyeless factor (ee), also carries the dominant red-eyed factor (PP) and is, therefore, of the genotype (PPee). The purple parent, on the other hand, in addition to carrying the recessive purple factor (pp) also carries the dominant factor eyed (EE) and, therefore, is of the genotype (ppEE). The F_1 offspring resulting from the above matings would, therefore, be all red-eyed of the genotype (PpEe).

TABLE 2.—*F_2 offspring obtained by mating the F_1 together.*

Source of F_1.	Red-eyed.			Purple-eyed.			Eyeless.		
	Males.	Females.	Total.	Males.	Females.	Total.	Males.	Females.	Total.
From eyeless females × purple-eyed male	451	435	886	157	150	307	107	136	243
From purple-eyed females × eyeless male	484	405	889	161	222	383	175	191	366
Total	935	840	1,775	318	372	690	282	327	609

MASS MATING OF THE F_1 TO OBTAIN F_2

In order to obtain the different F_2 phenotypes and their ratio, the F_1 of the two reciprocal crosses were mated together and the offspring were examined as to sex and eye characteristics. There were obtained in the F_2 three phenotypes: *red-eyed, purple-eyed,* and *eyeless* (Table 2). Theoretically, there should be eyeless carrying red and eyeless carrying purple, but due to the absence of eyes in both of them, they all appear together as eyeless. The F_2 results would, therefore, give a modified Mendelian dihybrid phenotypic ratio of 9 red-eyed: 3 purple-eyed: 4 eyeless, if they were all equally viable. The three phenotypes should theoretically contain the following genotypes:

9 Red-eyed	:	3 Purple-eyed	:	4 Eyeless	
1 PPEE		1 ppEE		1 PPee	1 ppee
2 PpEE		2 ppEe		2 Ppee	1 pe
2 PPEe		3 pE		3 Pe	
4 PpEe					
9 PE					

The above ratio of 9: 3: 4 was not, however, realized in the F_2 of both reciprocal crosses, there being too few eyeless in proportion to the red-eyed and purple-eyed phenotypes. In a total of 3,074 F_2 flies, 1,775 were red-eyed, 690 were purple-eyed, and only 609 were eyeless. If the 9 : 3: 4 ratio be correct, there should be, theoretically, 1,729 red-eyed, 576 purple-eyed, and 768 eyeless flies (Table 3). The actual result obtained deviates from

TABLE 3.—*Comparison of the actual and theoretical number of F_2 offspring based on the 9: 3: 4 ratio.*

F_2 phenotypes.	Actual number.	Theoretical number.	Deviation.
Red-eyed	1,775	1,729 1/8	+ 45 7/8
Purple-eyed	690	576 3/8	+113 5/8
Eyeless	609	768 1/2	—159 1/2
Total	3,074	3,074	0

the theoretical expectation by an excess of 45 flies in the case of red-eyed, and 113 flies in the case of the purple-eyed, while the eyeless is short 159 flies. The great reduction in the number of eyeless flies in the F_2 is certainly significant and this may mean one or the other of the following possibilities: It may mean that the eyeless are not as highly viable as the red-eyed and purple-eyed flies or that a certain genotype of the eyeless flies such as those which are homozygous for both eyeless and purple (ppee) is lethal. The first assumption can be dismissed because it has been shown by Clemente (6, 7) that the viability of both eyeless and purple is about the same and why is there such a great discrepancy in the eyeless as compared with the purple-eyed when the eyeless in this specific instance should be the more numerous? There remains the possibility that a certain phenotype of the eyeless, such as the homozygous purple eyeless (ppee), is lethal, in order to explain their great deficiency in number among the F_2 offspring. If this assumption be correct, the F_2 phenotypic ratio would be 9 red-eyed : 3 purple-eyed : 3 eyeless. A comparison of the actual number obtained of the different F_2 phenotypes and the theoretical number calculated based on the 9 : 3 : 3 ratio seems to bear out this explanation (Table 4).

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TABLE 4.—*Comparison of the actual and theoretical number of F_2 offspring based on the 9:3:3 ratio.*

F_2 phenotypes.	Actual number.	Theoretical number.	Deviation.
Red-eyed	1,775	1,729⅛	+ 45⅞
Purple-eyed	690	576⅜	+113⅝
Eyeless	609	576⅜	+ 32⅝
Total	3,074	2,881⅞	—192⅛

MASS MATING OF THE F_2 PURPLE-EYED

The mass mating of purple F_2 is a crucial test in the determination as to whether the individuals that are homozygous for both purple and eyeless (ppee) are lethal or not. If in this cross eyeless individuals are produced, it will be positively proven that they are nonlethal. If on the other hand, no eyeless are produced, the purple eyeless (ppee) must be regarded as lethal.

TABLE 5.—*Results of mass mating of the F_2 purple-eyed.*

Source of F_2 purple-eyed.	Purple-eyed.			Eyeless.		
	Males.	Females.	Total.	Males.	Females.	Total.
From eyeless female × purple male	241	235	476	0	0	0
From purple female × eyeless male	232	259	491	0	0	0
Total	473	494	967	0	0	0

Theoretically, there are two genotypes (ppEE) and (ppEe) among the F_2 purple in the proportion of one of the former to two of the latter. A mass mating of these at random should produce purple-eyed of the genotypes (ppEE and ppEe) and purple-eyeless of the genotype (ppee). By using the formula of Jennings (10) in such random mating where (s) stands for 2 (ppEe) and (r) for 1 (ppEE), the relative proportion of the different genotypes in the offspring would be as follows:

$$\frac{(s + 2r)^2 \text{ ppEE} + s^2 \text{ ppee} + 2s\ (s + 2r) \text{ ppEe}}{4(s + r)^2} =$$

$$\frac{16 \text{ ppEE} + 4 \text{ ppee} + 16 \text{ ppEe}}{36} =$$

$$\frac{4 \text{ ppEE} + 1 \text{ ppee} + 4 \text{ ppEe}}{9}.$$

Table 5 shows the result of this cross. In a total of 967 flies, of which 473 were males and 494 were females, not a single eye-

less fly was produced. If the eyeless purple were nonlethal, there should be 1 purple eyeless to every 8 purple-eyed flies produced in this mating. It means that at least 120 purple eyeless were expected to the 967 purple-eyed flies that were produced, but as previously stated, not a single purple eyeless was found. This result proves beyond doubt that the individuals that are homozygous for both purple and eyeless (ppee) are lethal or nonviable.

BACK-CROSSING OF THE F_1 TO PURPLE STOCK

This mating was done in order to find out whether purple-eyed of the genotype (ppEe) is lethal or viable. A knowledge of the viability or nonviability of this genotype of purple-eyed is necessary because it may mean that the reason why no purple eyeless (ppee) was produced in the mass mating of the F_2 purple-eyed was that (ppEe) are themselves nonviable. If in this mating it can be proven that they are viable, the failure of the purple eyeless (ppee) to appear in the mass mating of the F_2 purple-eyed is due to the lethal effect of the combined genes of purple and eyeless and not to other causes.

This cross should give, theoretically, red-eyed and purple-eyed in equal numbers and each phenotype should consist of two genotypes as follows:

Red-eyed F_1 × Purple-eyed stock

↓ ↓

PpEe ppEE

↓ ↓ ↓ ↓

PE + Pe + pE + pe

↓

pE

PpEE + PpEe + ppEE + ppEe

(Red-eyed.) (Purple-eyed.)

The results of this cross are shown in Table 6. In a total of 192 flies produced, 92 were red-eyed and 100 were purple-eyed or a ratio that is approximately 1 : 1. This is exactly what would be expected if the two genotypes of the purple-eyed (ppEE and ppEe) are as equally viable as the two genotypes of the red-eyed (PpEE and PpEe). If the purple-eyed of the genotype (ppEe) were lethal there would be produced in this mating individuals in the proportion of 2 red-eyed to 1 purple-eyed. But this was not found to be the case. This cross, therefore, proves conclusively that purple of the genotype (ppEe) is viable

and that the failure of the purple eyeless (ppee) to appear in the mass mating of the F_2 purple is due to the lethal effect of the combined genes of purple and eyeless and not due to other causes.

TABLE 6.—*Results obtained in a back-cross of the F_1 to purple stock.*

Source of F_1.	Red.			Purple.		
	Females.	Males.	Total.	Females.	Males.	Total.
From eyeless female × purple-eyed male	38	31	69	43	31	74
From purple female × eyeless male	--------	--------	23	--------	--------	26
Total	38	31	92	43	31	100

It might be stated in this connection that the proportion of the purple-eyed to the red-eyed and eyeless in the F_2 is also strong evidence in support of the theory that the purple-eyed of the genotype (ppEe) is viable. If they were lethal, the number of purpled-eyed F_2 would be reduced by two-thirds and there would be only 1 purple-eyed to every 9 red-eyed flies. The actual numbers obtained, as can be seen in Table 2, is approximately 1 purple-eyed to every 3 red-eyed flies, thus precluding all doubts as to the viability of purple-eyed of the genotype (ppEe).

BACK-CROSSING OF THE F_1 TO EYELESS STOCK

The next question which needs to be solved is whether or not the eyeless of the genotypes (Ppee) is lethal. This cross is necessary in order to find out whether the great reduction in the number of eyeless in the F_2 is due to the death not only of the purple eyeless (ppee) but also of the eyeless of the genotype (Ppee). This was done by back-crossing the F_1 (PpEe) red-eyed to the eyeless stock which carries the red gene in homozygous condition (PPee). This mating should give, theoretically, red-eyed and eyeless in equal numbers with each phenotype representing two genotypes as follows:

Red-eyed F_1 × Eyeless (Red)

↓ ↓

PpEe PPee

↓ ↓ ↓ ↓

PE + pE + Pe + pe

↓

Pe

PPEe + PpEe + PPee + Ppee

(Red-eyed.) (Eyeless.)

As can be seen in Table 7, the two expected phenotypes, red-eyed and eyeless, were realized in about equal numbers, there being 47 red-eyed and 41 eyeless in a total of 88 flies. This equality in the numbers of red-eyed and eyeless flies is conclusive proof that the two genotypes of the red-eyed (PPEe and PpEe) are as viable as the two genotypes of the eyeless (PPee and Ppee). If the eyeless of the genotype (Ppee) were lethal, the result in this mating would be in the proportion of 2 red-eyed to 1 eyeless instead of 1 to 1 as was obtained.

TABLE 7.—*Results obtained in a back-cross of the F_1 to eyeless stock.*

Source of F_1.	Red-eyed.			Eyeless.		
	Females.	Males.	Total.	Females.	Males.	Total.
From eyeless female × purple-eyed male	11	17	28	14	15	29
From purple female × eyeless male	--------	--------	19	--------	--------	12
Total	11	17	47	14	15	41

The proportion of the eyeless to the red-eyed in the F_2 is strong evidence in support of the theory that the eyeless of the genotype (Ppee) is viable. If this genotype of the eyeless were nonviable, the already reduced number of F_2 eyeless due to the death of the homozygous purple eyeless (ppee) would further be reduced to such an extent that there would be only 1 eyeless to every 9 red-eyed flies. The actual result obtained in the F_2, as can be seen in Table 2, does not seem to bear this out. There are on the average 3 red-eyed flies to 1 eyeless fly, which helps to prove conclusively that the eyeless of the genotypes (Ppee) is nonlethal.

SUMMARY AND CONCLUSIONS

It can be concluded from the above experiments that the flies which are homozygous for both purple and eyeless (ppee) die as shown by their failure to appear in all crosses. This is especially shown in the mating together of the F_1 to produce F_2 and in the mass mating of the F_2 purple.

The results obtained in the F_2 which gave an approximate ratio of 9 red-eyed : 3 purple-eyed : 3 eyeless instead of the theoretical 9 red-eyed : 3 purple-eyed : 4 eyeless, is strong evidence in support of the theory that the eyeless purple (ppee) is nonviable. If it were viable, there would have been more eyeless flies than purple-eyed in the proportion of 4 : 3.

The mass mating of F_2 purple failed to produce a single eyeless fly. Theoretically, one of every nine flies in this mating should be eyeless if the purple-eyeless (ppee) is nonlethal, inasmuch as two of every three F_2 purple-eyed flies are heterozygous for the eyed condition. The total absence of eyeless among hundreds of offspring by mass mating of F_2 purple is indisputable proof that the purple-eyeless combination is lethal.

It can also be concluded from these experiments that other combinations of eyeless and purple, such as purple-eyed of the genotype (ppEe) and red-eyeless of the genotype (Ppee), are viable or nonlethal. These were proven by back-crossing the F_1 which are double heterozygous (PpEe) to purple-eyed stock (ppEE) on one hand and to red-eyeless (PPee) on the other.

The fact that a 1 : 1 ratio of red-eyed to purple-eyed flies was obtained in a back-cross of F_1 red-eyed (PpEe) to purple-eyed (ppEE) is good proof that the purpled-eyed of the genotype (ppEe) is viable. If it were lethal there would have been produced in this cross a ratio of 2 red-eyed to 1 purple-eyed.

In a similar way the 1 : 1 ratio of red-eyed to eyeless flies obtained by back-crossing the F_1 red-eyed (PpEe) to red-eyeless stock (PPee) is a good indication that eyeless of the genotype (Ppee) is viable or nonlethal. If it were lethal the offspring resulting from this cross would have been in the proportion of 2 red-eyed to 1 eyeless.

These experiments present a new case of zygotic lethal factor in which, instead of a single gene in homozygous condition as responsible in the death of an organism as heretofore reported, two sets of independent genes in homozygous condition were found to be the cause of the lethal effect.

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THE CENTRAL NERVOUS, TRACHEAL, AND DIGESTIVE SYSTEMS OF A NYMPHOMYIID FLY[1]

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ONE PLATE AND FIVE TEXT FIGURES

In my previous paper (1935), on the external anatomy, I reported that the paired lateral organs just caudad of the compound eyes of *Nymphomyia alba* Tokunaga may be certain sensory organs related to the adaptive or larval ocelli, rather than to the primary adult ocelli, and, likewise, I touched on the arrangement of the abdominal ganglia. However, their details were not studied. Now I intend to discuss the whole structure of the central nervous system to complement my previous report. Moreover, after reëxamination of living material, as well as of sections, I can now elucidate the entire tracheal system of this fly in addition to confirming an earlier preliminary theory that the posterior pair is the true spiracle of the metathorax and that the anterior one is not a respiratory pore but a sensory pore. The true spiracle of the mesothorax is displaced far cephaloventrad, being located on the ventral corner of the postpronotal plate. Further and more-detailed data on the alimentary canal are also included.

In the study of the central nervous and digestive systems sections were mainly resorted to. Reconstructions were made from paraffin sections, especially for the investigation of the supra- and subœsophageal ganglia. For the study of the tracheal system living material was dissected in distilled water and the dismembered pieces were mounted in water. The material was preserved in a 4 per cent aqueous solution of formalin. This reagent does not rapidly penetrate into the tracheæ; hence, they remain filled with air, which makes them appear as dark or silvery lines under transmitted or reflected light. Soon after dissection of the living material both tracheæ and tracheoles show

[1] Contribution from the entomological laboratory, Kyoto Imperial University, No. 47.

distinctly; but after a short stay in the formalin solution the tracheoles disappear and then the tracheæ become transparent, even in the main tracheal trunks, due to the absence of the tinged or thickened spiral threads, or tænidia, in this fly. The material for the section method was fixed in Carnoy's fluid, stained with eosin-alcohol in toto, cleared in cedar oil, and embedded in paraffin the melting point of which is about 56° to 58° C. The serial sections were cut 8 microns thick and stained again with Delafield's hæmatoxylin-eosin. The material stained in toto with methylene blue and eosin was also dissected in cedar oil, and the pieces dissected were mounted in the same oil for observation.

This study was undertaken under the direction of Prof. Hachiro Yuasa, to whom I express my deepest thanks. I also thank Prof. Dr. T. Esaki and Dr. H. J. Feuerborn for the gift of invaluable literature.

CENTRAL NERVOUS SYSTEM

The central nervous system of *Nymphomyia alba* consists of the following separate ganglia: Two cephalic, three thoracic, and eight abdominal (text fig. 1, *A*). The separate condition and the noncoalesced eight abdominal ganglia in the present fly are very rare among the higher pterygotan insects, especially in the adult stage. In the dipterous insects a similar ganglionic condition is known in the larvæ of many orthorrhaphous families—Tipulidæ, Culicidæ, Mycetophilidæ, Chironomidæ, Leptidæ, Asilidæ, Bibionidæ, Therevidæ, Xylophagidæ, and Dolichopodidæ—but in the adult stage of these insects, at least, two posterior ganglia, the seventh and the eighth, are fused with each other, forming a ganglionic center, showing at most seven abdominal ganglia. The abdominal nervous system, as a whole, is displaced more or less cephalad (Brandt, K. d'Herculais, Perfiljew, and Miall and Hammond). This coalescence and cephalization have an important significance related to the specialization in phylogenetic and systematic directions (Beier, Deegener, Imms, et al.). Thus, the isolated and noncephalized condition of eight abdominal ganglia in the present insect is unusual among dipterous imagines. It probably represents a comparatively primitive type of development of the nervous system itself, bearing a relation to the loose fusion of the neuromeres of each ganglion and the wide separation of paired connectives throughout the thoracic and abdominal regions. Al-

though the two cephalic ganglia, supra- and subœsophageal, are closely united, forming a compact mass, as in other Diptera in general, the shape of the brain and relative position of various parts of cerebral lobes are highly characteristic and related to the specialization of the external structure of the head capsule itself. The nerves originating from the head ganglia are largely reduced, correlated with the extreme reduction of the trophic organs. The three thoracic ganglia are widely separated from each other, due to the elongation of the thorax, but normally arranged and not displaced from their primary segmental position.

Supraœsophageal and subœsophageal ganglia (text fig. 1, B and C).—The supraœsophageal ganglion is closely united with the subœsophageal one, is perforated by the œsophageal canal, and occupies almost the entire cavity of the head capsule. It is somewhat conical in general shape and is elongated along the longitudinal axis of the head; the optic lobes (*ol*) occupy the anterior pointed part of the conical brain and the paired lobes are closely applied to each other on the mesal side and not produced laterad, as is generally the case in other dipterous insects, which are provided with laterally projected paired optic lobes. Thus the optic nerves for the compound eyes (nerves between the periopticons and epiopticons) originate from the lateral side ot the cephalic projections of the frontal lobes (*fl*). Besides these modifications, the various elements constituting the supraœsophageal ganglion are very different topographically from those of the other dipterous insects.

The protocerebrum is very large, occupying more than the dorsal half of the supraœsophageal ganglion, and consists of small mushroom bodies, a large protocerebral bridge, a large central body, and several very large cerebral lobes.

The mushroom bodies (*mb*) are very simple and small, as in other nematocerous insects in general (Hanström), situated on the dorsocentral region of the brain, and two lateral bodies are widely separated from those of the other side by a large central body (*cb*) and protocerebral bridge (*pcb*). The two mushroom bodies of each side are closely united with each other, being actually fused partially on the basal parts of their peduncles. The lateral mushroom body is larger than the mesal, being provided with a larger calyx and peduncles. The calyx (*cx*) is also small, elongated oval, not ringlike or cuplike, thus differing from the typical calyx. The peduncle (*pe*) is short and very simple, not

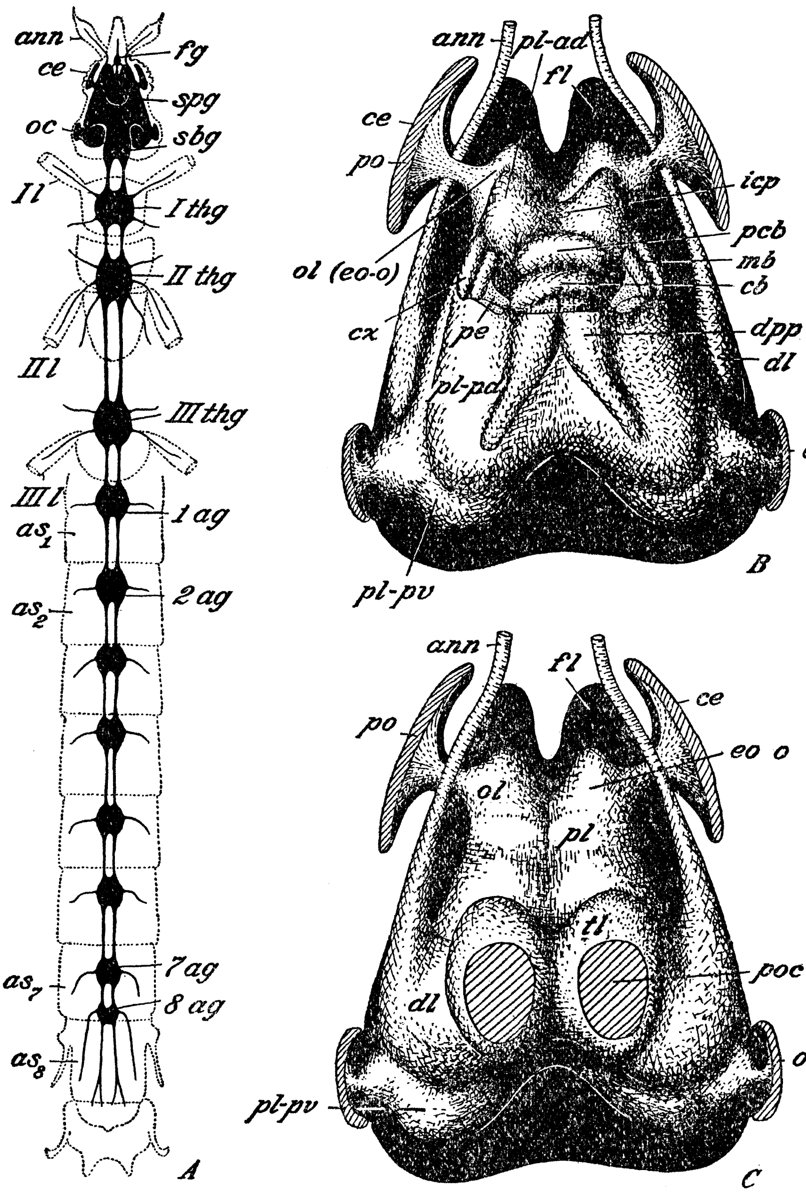

FIG. 1. Central nervous system of *Nymphomyia alba* Tokunaga. *A*, Arrangement of ganglia; *B* and *C*, dorsal and ventral aspects of supraœsophageal ganglion, showing metameric structure of neurospongium (cortical layer of ganglionic cells represented by black parts); *ag*, abdominal ganglion; *ann*, antennary nerve; *as*, abdominal segment; *cb*, central body; *ce*, compound eye; *cx*, calix; *dl*, deutocerebral lobe; *dpp*, middorsal lobe; *eo*, epiopticon; *fg*, frontal ganglion; *fl*, frontal lobe; *icp*, intercerebral part; *l*, leg; *mb*, mushroom body; *o*, opticon; *oc*, ocellus; *ol*, optic lobe; *pcb*, protocerebral lobe; *pl-ad*, anterior dorsal lobe; *pl-pd*, posterior dorsal lobe; *pl-pv*, posterior ventral lobe of protocerebrum; *po*, periopticon; *poc*, paraœsophageal connective; *sbg*, subœsophageal ganglion; *spg*, supraœsophageal ganglion; *thg*, thoracic ganglion, *tl*, tritocerebral lobe.

forming a complex structure, which attains the maximum in complexity in the Lepidoptera.[2] The development of the glomeruli associated with the mushroom body is very poor in the present fly.

The protocerebral bridge (*pcb*) and central body (*cb*) are well developed, subequal in shape and size, horizontally arranged, the former bridge being located cephalad, the latter being displaced from the normal vertical arrangement.

In addition to the above characteristic structures, the protocerebrum may be divisible into several lobes; namely, the paired middorsal (*dpp*), the anterior dorsal (*pl-ad*), the posterior dorsal (*pl-pd*), the optic (*ol*), and the posterior ventral lobes (*pl-pv*). The middorsal lobes are elongated, paired, situated on the middorsal side of the protocerebrum; their cephalic parts are fused with each other and located under the central body. The anterior dorsal lobe (*pl-ad*) is bicornuate posteriorly, located cephalad of the protocerebral bridge or dorsad of the optic lobes. In certain insects that are provided with primary ocelli, the nerves for the ocelli originated from this lobe. The posterior dorsal lobe (*pl-pd*) is very large, slightly bilobate on the posterior part, and not provided with distinct nerve cords. The optic lobes (*ol*) are not projected laterad but cephalad, being closely united with each other and forming a distinct, cephalic, bilobate frontal lobe (*fl*) accompanying a thick peripheral layer of ganglionic cells and highly different in their arrangement from that in other insects.

Histologically, this part of the optic lobe consists of the opticon, or internal medulla, and the epiopticon, or external medulla. From the lateral side of each optic lobe the nerve for the compound eye arises and forms a thin layer of the perioticon, or ganglionic lamina (*Po*), closely along the inner side of the compound eye. The opticon of the Diptera is said to be composed of three layers (Cajal and Sanchéz), but in *N. alba* these layers are not distinct and form a solid medullary mass. The posterior ventral lobe (*pl-pv*) is very large, extends caudad, and reaches the occipital margin of the head capsule. The large lateral ocellus (*oc*) is directly connected with the lateral side of this lobe by a very short nerve.

The deutocerebrum is comparatively large, located under the posterior ventral lobe of the protocerebrum and consists of large,

[2] Bretschneider, F., Jen. Zeit. Naturw. (1921 and 1924) 57 and 60.

compact, paired masses of the antennary glomeruli (*dl*), a narrow median bridge which connects the two masses of the antennary glomeruli, and a common cortical layer of ganglionic cells. The nerve for the antenna (*ann*) originates from the laterocephalic part of the deutocerebral lobe; it extends cephalad along the lateral side of the neurospongium of the brain and under the optic nerve through the cortical layer of the protocerebrum and then freely to the antenna from the cephalic end of the frontal lobe (*fl*).

The tritocerebrum (*tl*) is composed of paired oval tritocerebral lobes and the common cortical layer. The former are partially fused with each other on the mesal side. The nerves arising from these lobes cannot be clearly distinguished.

The development of the sympathetic nervous system associated with the supraœsophageal ganglion is very obscure, being represented only by the frontal ganglion (*fg*) and its delicate connectives, which originate from the mesal side of the tritocerebral lobes. From the frontal ganglion a fine frontal nerve extends into the snoutlike projection of the head and a delicate recurrent nerve caudad along the dorsal side of the œsophageal pump. Other sympathetic ganglia and the accessory nerves have not been demonstrated in this fly.

The subœsophageal ganglion is somewhat elongated, comparatively large, closely associated with the supraœsophageal ganglion, and connected with the latter ganglion by the large but short paraœsophageal connectives (*poc*); the neuromeres of this ganglion are closely fused with each other forming a compact mass of neurospongium. The nerves that arise from this ganglion for the various appendages of the mouth parts are almost completely degenerated, being correlated with the extreme reduction of the external structures of the trophic organ as in the case of the sympathetic nervous system of the head.

Thoracic and abdominal ganglia (*text fig. 1, A*).—The three thoracic ganglia (*I–IIIthg*) are widely separated from each other due to the elongation of the thoracic structures as a whole. Their position is normal, each ganglion being situated on the middle of the sternal region of each thoracic segment to which it properly belongs. The first and third ganglia are each provided with two pairs of main nerves, which are chiefly extended into the legs and muscles related to the body wall. The second ganglion, besides these main nerves, is provided with a pair of the alary nerves.

The abdominal central nervous system consists of eight isolated ganglia, including the ultimate ganglionic center, which is thought to be formed by the fusion of three ganglia at least. This polyganglionic condition of the abdomen of *N. alba* is thought to represent the maximum number of the abdominal ganglia for the Diptera, in the imaginal stage.

From the phylogenetic point of view (Beier, Deegener, Imms, et al.), this polyganglionic condition does not indicate that *Nymphomyia* belongs to a group higher than the Nematocera nor that this genus ranks high among the nematocerous groups. The polyganglionic condition of the imagines sometimes results from the decentralization of the elements as they exist in the oligoganglionic condition of the larvæ in various higher brachycerous families; such as, the Stratiomyidæ, Syrphidæ, Tabanidæ, Conopidæ, and acalypterous Muscoidea (Künckel d'Herculais). In these cases, however, the nervous system as a whole is located more or less anteriorly and never retains eight abdominal ganglia, usually far less than eight. The arrangement of the abdominal ganglia of *N. alba*, excepting the ultimate ganglionic center (*8ag*), is quite normal, as in the thoracic region, each ganglion being situated on the anterior part of the sternal region of each segment. The ultimate ganglionic center alone has migrated slightly cephalad and is in the preceding, seventh, abdominal segment (*as7*), but this tendency is widely and normally known in many insects, including immature forms of various orders, and even among the primitive apterygotan insects.

Each abdominal ganglion from the first to the seventh is provided with a pair of main nerves, which are chiefly distributed on the abdominal muscles. The ultimate ganglionic center consists of three pairs of distinct neuromeres, at least, from each of which originates a pair of main nerves for the muscles of the segment and various genital appendages. The first pair of these nerves originates independently from the cephalic neuromeres, while the second and third pairs, arising from the middle and caudal neuromeres, are closely united with each other, forming one cord on each lateral side, and forked far distad. Throughout the thorax and abdomen the paired neuromeres of each ganglion are not closely united with each other, and consequently the paired connectives between the ganglia are widely separated; that is, the transversal fusion between the paired lateral halves of the longitudinal series of the neuromeres

is not complete, differing from the higher dipterous insects. Other morphologic and histologic structures of the thoracic and abdominal nervous system, including the sympathetic nerves, are not so highly specialized from the other known cases to be mentioned.

TRACHEAL SYSTEM

In the most primitive condition twelve spiracles are present, being located on each of the thoracic and the anterior nine abdominal segments. This condition, however, is only known in the embryonic state of *Leptinotarsa.* In the postembryonic stages eleven pairs of spiracles, at most, are exceptionally present in the hyperpneustic insects, such as *Japyx* spp., which are provided with the prothoracic spiracles. Usually the number of spiracles is reduced to much less than eleven, especially in the higher Pterygota, the prothoracic spiracles being always atrophied in the adult condition, showing ten pairs in the holopneustic insects. Dipterous imagines show a great reduction in the number of abdominal spiracles, and sometimes the abdominal spiracles are completely or almost completely atrophied, as in *Deuterophlebia* (Edwards) and *Psychoda* (Kemper). This extreme reduction is found also in *N. alba,* in which all the abdominal spiracles are completely reduced.

The origin of the two thoracic spiracles of the pterygotan insects has been discussed by various authors, especially in the case of the Diptera. Many investigators (Feuerborn, Kemper, Lehmann, Palmen, Taylor, et al.) support the conclusion that the two paired thoracic spiracles of the adult insect properly belong to the meso- and metathoracic segments, respectively, and the prothoracic respiratory organs seen in the dipterous larvæ and pupæ, which are the secondary derivative, originally belonged to the mesothorax. If this theory of the thoracic spiracles is accepted, the unusual pronotal position of the first thoracic spiracles of the nymphomyiid fly is thought to be due to the cephaloventral displacement of the true mesothoracic spiracles.

In accordance with the extension of the tracheal branches, which are originally developed segmentally from the spiracular depressions, longitudinal and transversal anastomoses occurred between the tracheæ of the successive segments and the lateral halves. In the present case the development of the tracheal system is very low, exhibiting a vestigial condition. The longitudinal tracheal connection is represented only by the main dorsal trunk, which extends between the mesothoracic spiracle and the

eighth vestigial abdominal spiracle. The double connection is shown only between the metathorax and the first abdominal segment, highly differing from the condition in *Simulium* and *Psychoda,* which show the double tracheal connection between the meso- and metathoracic spiracles. Although the tracheal system of *N. alba* is very simple, it is different from the primary simple type of the Apterygota by the presence of the anastomoses, both longitudinal and transverse; it belongs to the tertiary simple type derived from the secondary complex type (Weber, 1933).

The longitudinal connections of the tracheal branches typically form three tracheal trunks on either side; namely, the dorsal, lateral, and ventral trunks. Judging from the distribution of the tracheal branches, in *N. alba,* the dorsal trunk alone remains as the main trunk, extending from the mesothorax to the eighth abdominal segment; the lateral one is almost atrophied, exhibiting a short trachea between the metathorax and the first abdominal segment. The ventral trunk is completely wanting. The lateral pairs of the tracheal system are usually connected with each other by the dorsal and ventral commissures. Although the ventral commissures of the abdomen are wanting in both imaginal and immature forms of the dipterous insects, the other commissures, as a rule, are well developed segmentally (Kemper, Kuster, de Meijere, Taylor, et al.). However, in *N. alba* they are greatly reduced, and only the first dorsal commissure of the thorax remains to connect the lateral halves of the entire tracheal system.

SPIRACLES

Respiratory openings of *Nymphomyia* are represented only by the two pairs of minute thoracic spiracles, and those of the abdomen are too highly reduced to be detected externally.

Thoracic spiracles (text fig. 2, A and B, and text fig. 3, A).— The metathoracic spiracle (*IIIsp*) is found in the position normal for a dipterous insect, close to the base of the haltere, while the mesothoracic spiracle (*IIsp*) is displaced far cephaloventrad from the normal position, being situated on the ventral corner of the triangular lateral plate of the postpronotum, as shown in text fig. 3, *A*. In the position where the mesothoracic spiracle would be expected in the nematocerous Diptera in general there is a minute spiraclelike pore (*ps*) which is a porelike sensorium.

Both mesothoracic and metathoracic spiracles open directly on the thoracic wall without accompanying special accessory scle-

rites or peritremes. These two spiracles are almost alike in structure and size. The cover plate of the spiracular chamber, or spiracular plate, is very thin and almost hyaline, bluntly convex externally, circular in outline, and about 9 microns in diameter. In the mesothoracic spiracle the opening of the spiracle, or porta atrii, is in the center of the circular cover plate, while in the metathoracic spiracle the porta atrii is slightly eccentric. The spiracular chamber, or atrium, is almost spherical and its wall is smooth and hyaline without special spinous or setigerous structures. There is a slight constriction between the atrium and the common base of the tracheæ. At this constriction the tracheæ are closed out from the atrium by means of two small spiracular muscles (*sm*) and an accessory closing ring (*sr*).

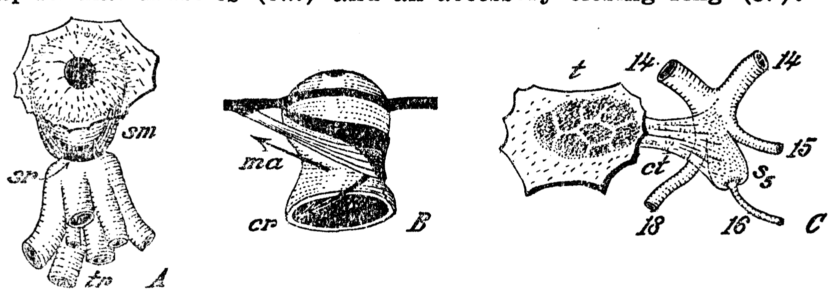

FIG. 2. Spiracles of *Nymphomyia alba* Tokunaga. *A*, metathoracic spiracle; *B*, diagrammatic structure of thoracic spiracle showing closing apparatus; *C*, vestigial spiracle of first abdominal segment; *cr*, direction of action of chitin ring; *ct*, ligamentous support; *ma*, direction of muscular action; *s*, spiracular chamber; *sm*, spiracular muscle; *sr*, closing spiracular chitin ring; *t*, paratergal tubercle; *tr*, trachea.

The mechanism of the closing apparatus is shown in text fig. 2, *B*. The free end of the spiracular ring applied at the constriction between the atrium and the tracheal base is pulled along the direction of *ma*-arrow by the contraction of the paired spiracular muscles; then the free end of the spiracular ring moves along the direction of *sr*-arrow, which is a part of a circular margin having its center at the hinge of the spiracular ring so as to close up the tracheal base from the atrium. The opening of the spiracle is due to the relaxation of the spiracular muscles and to the elasticity of the wall of the trachea and atrium, and not to the special antagonistic muscles.

Abdominal spiracles (*text fig. 2, C*).—The abdominal spiracles are highly reduced, their external openings being completely closed. These vestigial spiracles are found on the first eight abdominal segments. The first abdominal spiracle, however, is completely reduced and there is no trace of spiracular structures,

but the similar condition of the tracheal convergence to that of the other segments shows that the first abdominal spiracle has been situated on the middle of the paratergal lobe. The other vestigial spiracles are all alike in structure and position, except the eighth abdominal spiracle, which is modified slightly. On the paratergal lobe just caudad of the paratergal tubercle five tracheæ converge as shown in text fig. 3, *B*. The base of the ganglionic trachea is distinctly swollen, forming a special chamber as shown in text fig. 2, *C*. This swelling is thought to be a vestigial spiracular chamber, or atrium. The paratergal tubercle (*t*) and the spiracular swelling are connected by a delicate ribbon (*ct*). This ribbon acts as a segmental support for the tracheal system, although its original nature—whether it is merely a connective tissue or a stigmatic cord derived from the old atrium now shriveled—is not known. The vestigial spiracle of the eighth abdominal segment is found on the cephalic part of the dorsum. The spiracular support connects the spiracular swelling with the cephalic tubercle found at the base of the dorsal paratergal projection in the male and with that found on the paratergal lobe in the female. From the spiracular swelling of this segment a tracheal stem for the following segment extends caudad.

TRACHEÆ

All the tracheæ of this insect are hyaline and unprovided with especially thickened spiral threads, or tænidia, of the intima, resembling the tracheoles, even in the main tracheal trunk, although the figures given in the text show the tracheæ by tænidiumlike shading. The nomenclature of the tracheæ adopted in this report is based on the position of the tracheæ and the organs on which the main branches of the tracheæ are distributed.

Head and thoracic tracheæ (text fig. 3, A).—From each thoracic spiracle seven main tracheæ arise, and those that arise from the mesothoracic spiracle are distributed into the head, cervix, prothorax, and the cephalic half of the mesothorax and their various appendages, and those from the metathoracic spiracle into the caudal half of the mesothorax and the metathorax and their appendages.

The main tracheæ that arise from the mesothoracic spiracle are as follows:

1. *Dorsocephalic trachea.*—This trachea arises directly as a large independent stem from the spiracle, extended under the

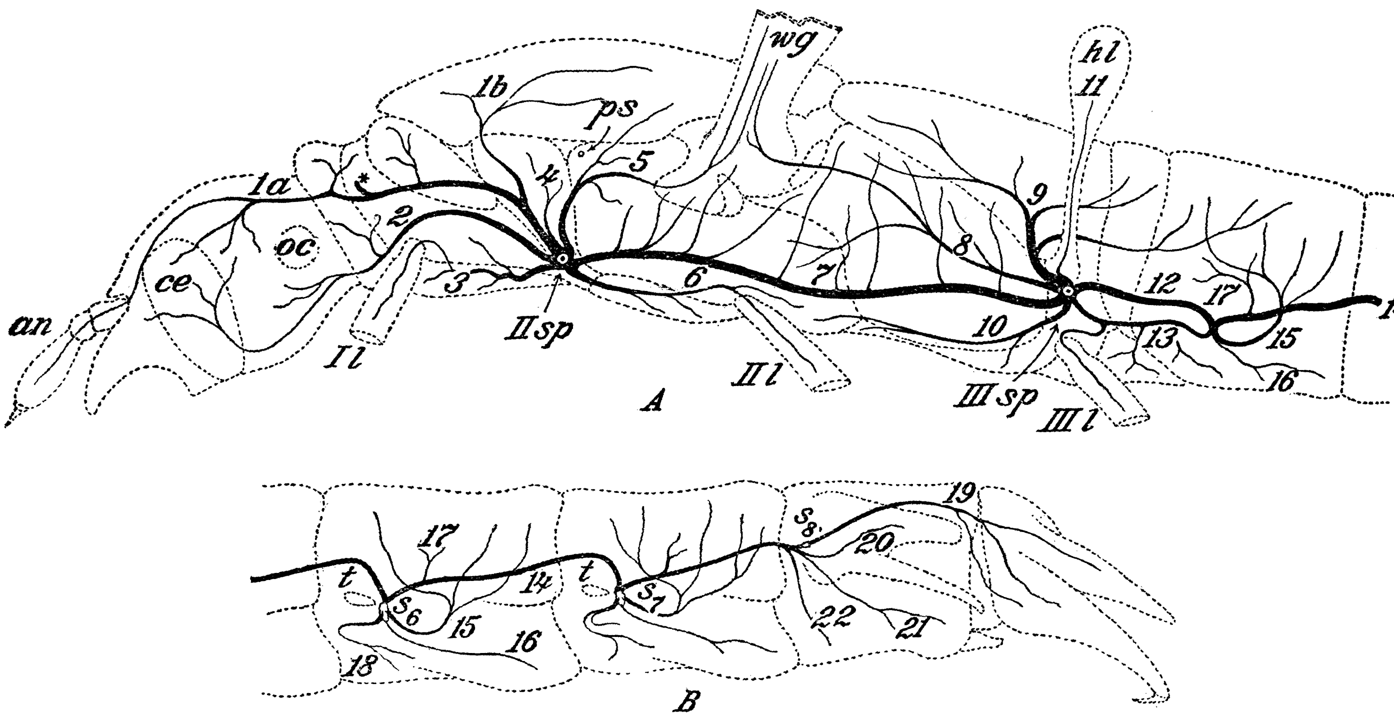

FIG. 3. Tracheal system of *Nymphomyia alba* Tokunaga. *A*, Main tracheæ of head, thorax, and first abdominal segment; *B*, main tracheæ of ultimate four abdominal segments of male; *an*, antenna; *ce*, compound eye; *hl*, halter; *l*, leg; *oc*, ocellus; *ps*, spiraclelike sensory pore; *s*, vestigial spiracle; *sp*, thoracic spiracle; *t*, paratergal tubercle; *wg*, wing; *1* to *22*, main tracheæ; *, transverse commissure.

pronotal plates and on the dorsal side of the head capsule forming a cephalic part of the dorsal trunk. Several tracheal branches issue from this stem. The first large trachea (*1b*) branches off under the postpronotal plate and ends in the tracheoles of the dorsal longitudinal and dorsoventral muscles of the mesothorax; the second branches off under the antepronotal plate and is distributed into the muscles concerned with this sclerite; the third and fourth branches arise on the cervical region and the former forms the transverse commissure (dorsal anastomosed trachea), which is the only commissure for this insect, and the latter ends on the dorsal cervical muscles; after the entrance into the head the fifth fine tracheal branch, which extends into the antenna, branches off and the remaining tracheæ are largely distributed into the supraœsophageal ganglion.

2. *Ventrocephalic trachea.*—This trachea has a very short common base with the propodical trachea and extends along the ventral margin of the pronotal plates and on the ventral side of the head capsule. Three main branches originate from this stem: The first branches off on the cervical region and terminates in the ventral cervical muscles; the second branches off on the head capsule and ends in the subœsophageal ganglion, and the third branch ends in the supraœsophageal ganglion. The tracheæ of the salivary gland and basipharynx are thought to branch off from this stem, although they were not distinctly demonstrated.

3. *Propodical trachea.*—This trachea extends along the lateral side of the prosternum, is provided with one or two small branches for the prosternal muscles and a small branch for the prothoracic ganglion, and enters into the foreleg.

4. *Pronotal trachea.*—This small trachea is located under the postpronotum, parallel to the dorsal head trachea, at the base appearing to be a branch of the latter stem and ends in the cervical muscles related to the postpronotum.

5. *Alary trachea.*—This trachea is comparatively large, arises as an independent trachea from the spiracle, extends dorsocaudad across the dorsal region of the mesopleuron, and enters the wing. Two small branches for the longitudinal and pleural muscles branch from this wing trachea.

6. *Mesopodical trachea.*—This trachea is also comparatively large, branches from a very short common base with the dorsal tracheal trunk, extends along the lateral side of the mesosternum, and ends in the middle leg. Three main branches arise

from this trachea before it enters the leg cavity; the first is distributed into the cephalic group of the mesosternal muscles, the second into the mesothoracic ganglion, and the last into the caudal group of the mesosternal muscles.

7a. *Dorsocaudal longitudinal trachea.*—This trachea is large and distinct, extending almost straight caudad, forming the main tracheal trunk or dorsal trunk, being anastomosed with the cephalic ends of the dorsocephalic longitudinal trachea of the metathorax. This thoracic tracheal trunk extends for its entire length along the ventrolateral side of the dorsal longitudinal muscle of the mesothorax and is provided with many small branches for the latter muscles and the dorsoventral muscles of this segment.

The metathorax is also provided with seven main tracheæ, which arise from the spiracle.

7b. *Dorsocephalic longitudinal trachea.*—This trachea forms a part of the thoracic tracheal trunk as already alluded to.

8. *Alary trachea.*—This trachea is comparatively large; it extends cephalad across the parascutella and ends in the wing. Under the parascutella several small branches issue for the dorsoventral muscles and the muscles concerned with the latter sclerite.

9. *Dorsal trachea.*—This is a large trachea, separated into three main branches, which are distributed into the postnotal part of the dorsal longitudinal muscles of the mesothorax and, perhaps, into the metapleuron.

10. *Ventral trachea (mesopodical trachea)*.—This trachea is comparatively large, extends cephalad along the ventral side of the parascutella, is provided with a few branches for the metathoracic ganglion and the caudal group of the mesosternal muscles, and is atrophied before it enters the middle leg.

11. *Haltere trachea.*—This small and delicate trachea arises from the base of the dorsal trachea and ends in the haltere.

12. *Dorsocaudal longitudinal trachea.*—This is a large trachea that extends caudad along the ventral side of the postnotal phragma of the mesothorax and forms a part of the main dorsal trunk (dorsal anastomosed longitudinal trachea), being anastomosed end to end with the dorsocephalic longitudinal trachea of the first abdominal segment. No distinct branch issues from this trachea.

13. *Metapodical trachea.*—This small trachea extends caudad parallel to the dorsal trunk and anastomoses with the ventro-

cephalic trachea of the first abdominal segment, forming the ventral connection. This ventral connection (ventral anastomosed longitudinal trachea) is provided with three main branches, the first of which is distributed to the hind leg, the second to the metasternal muscles, and the third to the sternal muscles of the first abdominal segment.

The ventral trachea of the head, as a rule, is distributed to various trophic organs of the head in addition to the head ganglia. In the present case, however, both external and internal trophic organs are highly reduced and the tracheal branches distributed on these organs were not demonstrated distinctly. According to Lehmann the visceral tracheæ of the thoracic segments typically arise directly from the spiracles, but in *N. alba* the thoracic visceral tracheæ were not observed; and, perhaps, they are greatly reduced, paralleling the reduction of the digestive canal. Concerning the tracheæ for the middle leg and hind leg, Chapman said that the posterior tracheal stem of the leg is fused with the anterior stem of the following segment before the entrance of the leg, and typically they form a Y-shaped anastomosis for each leg. This Y-shaped condition is regularly known in the tracheæ for the middle leg of the Diptera (*Simulium* and *Psychoda*) and that in the hind leg is usually wanting, while in *Nymphomyia* the similar condition is only shown in the hind leg. In the middle leg the anterior tracheal stem from the metathoracic spiracle is atrophied before the base of the middle leg. Although various modifications are reported in different insects by many writers (Lehmann, Kennedy, Kemper, Taylor, et al.), the wing tracheæ originally arise from the bases of the leg tracheæ, and two tracheæ from the different segments are connected by a secondary tracheal bridge at the base of each wing. This condition is retained even in the dipterous halteres in certain Nematocera (*Bittacomorpha*, by Chapman), while in *Nymphomyia* two tracheæ for a wing arise from the spiracles, being basally separated from the leg tracheal stems, and there is no secondary connection between these two wing tracheæ; moreover, the tracheæ for the haltere are represented only by one trachea, which arises from the metathoracic spiracle, not accompanying that arising from the first abdominal segment. Tracheæ for the thoracic ganglia are not fused with those of the opposite side, thus differing from many dipterous insects, which are typically provided with three ventral commissures on the thorax.

Abdominal tracheæ (text fig. 3, B).—The tracheation of the abdominal segments, except that of the two ultimate segments, is closely similar in all the segments. Typically each segment is provided with six main tracheæ, five of which directly arise from the vestigial spiracle, as shown in text fig. 3, *A* and *B*. The main tracheæ of the typical abdominal segment are as follows:

14. *Dorsal longitudinal tracheæ.*—Each of these two tracheæ extends cephalad and caudad along the lateral paratergal fold, respectively; they form the dorsal tracheal trunk, being connected anteriorly and posteriorly with those of the adjacent segments.

15. *Large dorsal and visceral tracheæ.*—These two tracheæ form a common stem, which extends ventrocaudad from the vestigial spiracle, and the majority of the branches are distributed on the dorsal muscles and only a few branches end in the visceral organs, especially the reproductive organs.

16. *Ventrocaudal trachea (ganglionic trachea).*—This is a fine trachea that extends into the abdominal ganglion and is without distinct branches.

17. *Small dorsal trachea.*—This is a small branch of the dorsocaudal longitudinal trachea and is distributed into the tergal muscles and perhaps into the dorsal vessel.

18. *Ventrocephalic trachea.*—This trachea is distributed to the sternal and pleural muscles. In the first abdominal segment, as already alluded to, this trachea forms the ventral connection, being fused with the trachea for the hind leg.

In the two ultimate segments the tracheal distribution is different from that of the preceding segments. In the eighth segment there are four main tracheæ, of which the ventral three are distributed into the eighth segment and the other extends far caudad, ending in the ultimate segment.

19. *Dorsocaudal longitudinal trachea (large dorsal trachea).*—This trachea arises from the vestigial spiracle of the eighth abdominal segment, extends caudad, forming the caudal part of the dorsal trunk, and branches off into three delicate tracheæ. These branches end in the reproductive organs and the muscles related to the cercus and coxite when present.

20. *Small dorsal trachea.*—This is a small trachea mainly distributed on the dorsal muscles of the eighth segment.

21. *Ventrocaudal trachea.*—This small trachea extends caudoventrad and ends in the reproductive organs in this segment and in the eighth abdominal ganglion.

22. *Ventrocephalic trachea.*—This is also a small trachea, which ends in the sternal muscles of the eighth segment.

The visceral tracheæ of the abdomen of *N. alba,* except those of the ultimate two segments, are more or less reduced and do not arise as the independent tracheal stems, differing from those of many dipterous insects. Typically, in the present fly, there are no intersegmental ventral connections, all the ventral and ganglionic tracheæ ending intrasegmentally. The transverse commissures are also wanting in the abdomen, the large dorsal trachea being atrophied before the connection with that of the opposite side, differing in this respect from the dipterous insects in general.

DIGESTIVE SYSTEM

The alimentary canal of the adult of *Nymphomyia alba* is simple, very poor in development, slightly convoluted on its caudal part, and divisible into three regions and several subregions morphologically and histologically (text fig. 4).

The first region, the fore intestine (*f-int*), is slender, extended caudad to the cephalic margin of the metasternum. The anterior portion of the fore intestine (*bx-op*), as reported in my previous paper (1935), consists of a short basipharynx and a large œsophageal pump and is provided with characteristic dilator muscles (dilator of pharynx, muscles of salivary pump, anterior dorsal dilator of œsophageal pump, posterior dorsal and ventral dilators of œsophageal pump). Histologically this anterior portion is invested with a thick common layer of ring muscles and lined with a thick layer of chitinous intima. The epithelial layer of this portion is comparatively thick and the epithelial nuclei are large and oval. The posterior portion of the fore intestine, the œsophagus (*oe*), is a very delicate slender canal and without an accessory muscular system (Plate 1, fig. 1). The epithelial layer is reduced to a very thin membrane, and the nuclei (*dn*) are also highly degenerated, being represented by small discoidal masses of chromatin. The chitinous intima (*ch*) is also very thin. Often the wall of the œsophagus seems to be represented by a single, delicate, structureless membrane, the

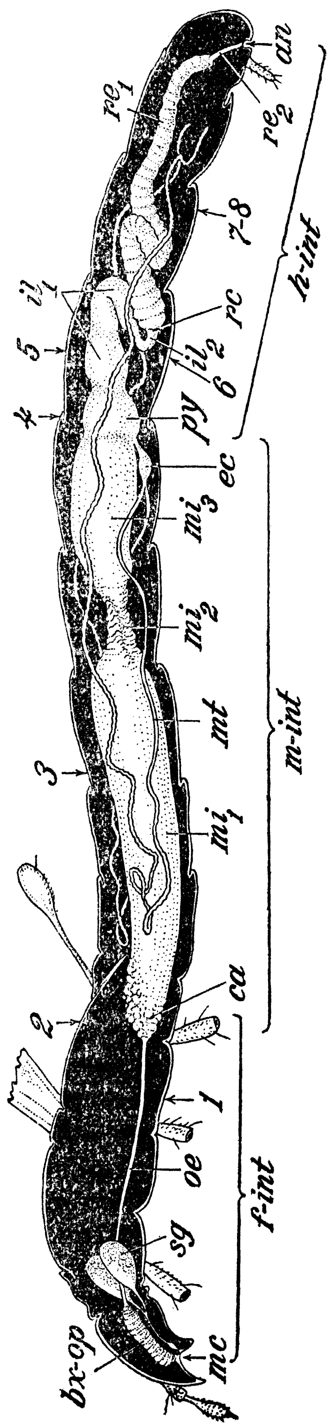

FIG. 4. Digestive system and Malpighian tubes of *Nymphomyia alba* Tokunaga. *an*, Anus; *bx*, basipharynx; *ca*, cardia; *ec*, excretory chamber; *f-int*, fore intestine; *h-int*, hind intestine; *il*, ileum; *mc*, mouth cavity; *mi* and *m-int*, middle intestine; *oe*, oesophagus; *op*, oesophageal pump; *py*, pylorus; *rc*, rectal constriction; *re*, rectum; *sg*, salivary gland; *1–8*, cross sections of alimentary canal illustrated in Plate 1.

epithelium being almost completely degenerated and the two layers, intima and basement membrane, being directly and closely applied to each other.

This fly has no trace of a crop, or sucking stomach, thus differing from the flies provided with junctional trophic organs. With regard to the reduction of the crop of a chironomid fly, Miall and Hammon (1900) state that before the pupation the œsophagus is expanded, forming a ventral diverticulum, which probably represents the sucking stomach of some winged Diptera, but it shrinks rather rapidly and in the late pupa is nearly obliterated, the epithelium being then irregularly folded. Throughout the fore intestine neither longitudinal muscles nor peritoneal membrane was found.

In the dipterous larva, as a rule, the cardiac structures are well developed, being provided with the cardiac valvula, ring muscles, or sphincter muscles, cardiac gland cells, and sometimes with the enteric cæcum. In the imaginal stage, however, these structures are more or less modified or reduced, especially in short-lived flies. In the present insect the cardiac portion (*ca*) is highly reduced, being macroscopically represented by a small, irregularly folded

portion at the junction between the fore and the middle intestines. The cardiac valvula formed by the diverticulum of the fore intestine into the enteric cœlom is almost completely reduced as in a psychodid adult (Hövener). The epithelial layer of this portion (Plate 1, fig. 2) remains a comparatively thick syncytiumlike cellular layer and is provided with small oval nuclei. The peritrophic membrane (*pm*) is secreted from this portion of the epithelium. Although Hövener (1930), in the case of *Psychoda,* showed the three different cardiac cell groups differentiated from the cardiac epithelium of the middle intestine and the double nature of the peritrophic membrane, in *N. alba* these features were not observed, the cardiac epithelium consisting of a uniform cellular layer and the peritrophic membrane being a single layer. Chemically, from the peritrophic membrane the chitin substance was detected by Campbell as well as from the exoskeletons of various insects. Judging from this fact these cardiac glandular cells are thought to be ectodermal in origin as in the epithelium of the fore intestine.

The middle intestine (*m-int*) is very large, occupying almost the entire body cavity of the first five abdominal segments, distinctly constricted and rarely slightly convoluted at the fourth abdominal segment. In life the middle intestine is filled with watery hyaline fluid and contains gas bubbles. The wall of the anterior (mi_1) and of the posterior portion (mi_3) of the middle intestine is very delicate, consisting of a very thin basement membrane as shown in Plate 1, fig. 3. The epithelium (*dep*) is highly or almost completely degenerated, as in the œsophageal portion, and no sign of secretion or absorption was demonstrated. A similar feature of the middle intestine is also known in a chironomid imago (Miall and Hammond). In the constricted portion (mi_2) the epithelium is similar in structure to the other parts of the middle intestine, but there is a specially developed additional muscular investment, which consists of very delicate ring muscles and dorsal and ventral longitudinal muscles.

Just behind the posterior portion of the middle intestine there is a short cœlum of the pylorus (*py*). This portion (Plate 1, fig. 4) is lined with chitinous intima (*ch*), showing the ectodermal origin, and the epithelium is comparatively thick. In a typical fly this portion is provided with a valvula at the entrance of the pylorus, but in *N. alba* this pyloric valvula is not developed. The muscular investment is also wanting.

The main region of the hind intestine (*h-int*) is divisible into the ileum (*il*) and the rectum (*re*) by a constriction (*rc*), and each of these portions is convoluted twice. The ileum is subdivisible into a large anterior (il_1) and a small posterior part (il_2). The anterior ileum (Plate 1, fig. 5) is provided with a ring-muscular investment (*cm*); the epithelium consists of a flattened cellular layer, and the epithelial nuclei (*ne*) are large and irregular in shape. While in the posterior ileum (Plate 1, fig. 6) the muscular investment is wanting, the epithelium is comparatively thick and the epithelial nuclei are small, being degenerated into chromatic masses. At the constriction (*rc*) of the hind intestine the ileum is folded into the rectum, forming a small valvula, as in *Psychoda* (Hövener).

The rectum is subdivisible into a large anterior (re_1) and a very small posterior portion (re_2). The anterior portion (Plate 1, figs. 7 and 8) is invested with a strong ring-muscular layer, which is closely applied on the thick epithelial layer. The epithelial cells (*ep*) are somewhat columnar in appearance. This feature may be due to the folding of the flattened epithelium, which is originally similar in structure to that of the anterior portion of the ileum, by the contraction of the strong ring muscles. The posterior portion of the rectum is similar in histologic structure to the œsophageal portion, merely consisting of the chitinous intima and basement membrane, and the epithelium being almost completely degenerated. At the end of this posterior portion there is a small anal sphincter. Throughout the hind intestine the basement membrane (*bm*) is slightly thicker than in the other region, and the peritoneal membrane (*ptm*) is more developed. The special rectal glands or glandular cells were not found.

The paired large salivary glands (*sg*) are retained in the present fly, thus differing from *Psychoda* and *Chironomus*. However, the wall of the gland is reduced to a very thin membrane, the epithelium being almost completely degenerated and the nuclei being also reduced to compact masses of chromatic granules. The epithelium of the neck region alone remains as a comparatively thick layer, but shows no secretory feature of the saliva. The salivary duct is lined with chitinous intima, which shows a tænidiumlike spiral structure as in the trachea, and its epithelium has become very thin. At the anterior end of the common salivary duct there is a salivary pump, which is

provided with a group of special muscles as I have already stated (1935).

As mentioned above, the digestive system of *N. alba,* although more or less modified or reduced, is provided with various structures corresponding to those of the typical alimentary canal of an insect. However, histologic research yields no evidence of a digestive function. Probably the digestive system retains merely its external appearance as a remnant of the preëxistent functional organ and is now reduced to a nonfunctional organ.

MALPIGHIAN TUBES

The number of the Malpighian tubes is four in the Diptera in general, and exceptionally an uneven number (three or five) is known, in *Forcipomyia* (Saunders), *Culex* (Schindler), *Psychoda* (Hövener), and *Deuterophlebia* (Pulikovsky). These oligonephric conditions of the Diptera are derived from the original six-tube condition by reduction, but not by fusion (Schindler and Wheeler). In *N. alba* there are only two tubes, probably the minimum number for the Diptera. The paired tubes, as shown in text fig. 4, extend cephalad along the ventrolateral sides of the alimentary canal, turn backwards in the first abdominal segment, then extend caudad along the dorsolateral sides of the alimentary canal, and end freely in the eighth abdominal segment. The first ventral section of the Malpighian tube is slenderer and less curly than the second dorsal section, but there is no other morphologic or histologic difference between these two sections. Throughout the entire length of the tube the cells are linearly arranged, the central cœlom (*cc*) of the tube, then, being represented by the longitudinal communication of the intracellular canal as shown in text fig. 5. The greater part of the tube is black or dark brown due to the pigmentation of colored granules (*pg*); several of the most proximal cells are hyaline and contain no pigmented granules.

Histologically the Malpighian tube is invested with a very delicate basement membrane (*bm*). The cell is comparatively large, with a very large oval nucleus (*n*), many small spherical black or dark brown pigmented granules (*pg*), and two or three intracellular canaliculi (*ic*), which communicate with the central canal (*cc*). The inner surface of the cell forms a special protoplasmic zone (*iz*), which is more strongly stained with eosin dye than the other part, but does not exhibit the structure

known as "Stäbchensaum." In many species the cells of the Malpighian tubes exhibit outer peripheral striæ, but in *N. alba* this striated appearance was not observed. The muscular investment is also wanting.

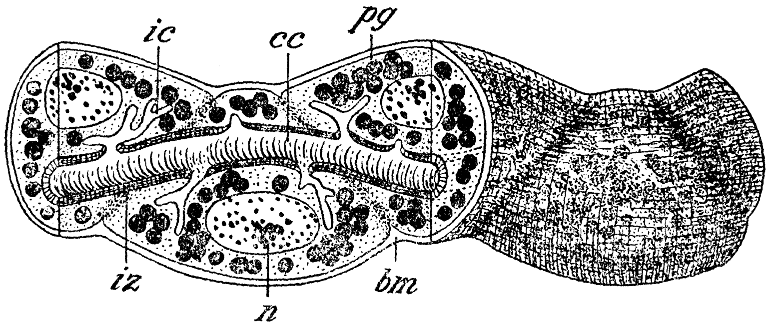

FIG. 5. Semidiagrammatic structure of Malpighian tube of *Nymphomyia alba* Tokunaga. *bm*, Basement membrane; *cc*, central canal; *ic*, intracellular canaliculus; *iz*, inner protoplasmic zone; *n*, nucleus; *pg*, pigment granule.

The two Malpighian tubes (*mt*) of the present insect open into an unpaired, common, excretory chamber, or bladder (*ec*). This chamber is located on the ventral side of the posterior end of the middle intestine, opens into the pylorus at the junction between the middle and hind intestines, and pulsates slowly in life. The presence of the excretory chambers, or common urinary ducts, is known in many insects, such as *Hippobosca*, *Musca*, *Sarcophaga*, *Anthrax*, *Conops*, *Oestrus*, and *Syrphus* (Schindler); in these genera, however, the excretory chambers are paired and at least two in number, each being present on the lateral side of the alimentary canal, highly different from the condition in the present insect. This unpaired condition of *Nymphomyia* may be due to the fusion of the originally paired chambers. Histologically the excretory chamber consists of a thin flattened epithelium and a delicate peritoneal membrane, which contains fine, reticular, muscular fibers. The chitinous intima was not observed.

SUMMARY

The anatomical investigation of the central nervous, tracheal, and digestive systems and their accessory organs in *Nymphomyia alba* is summarized as follows:

1. The metameric arrangement of the neurospongium of the supraœsophageal ganglion is distinct, while that of the subœsophageal ganglion is very obscure, and the neurospongium forms a compact ganglionic mass.

2. The protocerebrum is subdivisible into several distinct lobes. The optic lobes are extended cephalad and closely united with each other on the mesal margins. The lateral ocelli are directly connected with the posterior ventral lobes of the protocerebrum, highly differing in position from the primary adult ocelli. The mushroom bodies are very small. The protocerebral bridge and central body are well developed and arranged in a horizontal plane. The antennary nerves are well developed.

3. The sympathetic nervous system and the nerves originating from the subœsophageal ganglion are highly reduced in relation to the extreme reduction of the external and internal trophic organs.

4. Three thoracic and eight abdominal ganglia are distinctly isolated from each other, and throughout the thorax and abdomen the paired longitudinal series of neuromeres are loosely fused by transverse commissures. These features of the thoracic and abdominal ganglia are thought to suggest the primitive condition of the dipterous nervous system.

5. There are only two pairs of functional spiracles throughout the entire length of the insect; namely, the meso- and metathoracic spiracles. Each thoracic spiracle is provided with a closing apparatus, which consists of two spiracular muscles and a spiracular chitin ring.

6. The abdominal spiracles are greatly reduced and always closed. The trace of spiracles is shown on the first eight abdominal segments. The vestigial spiracle typically consists of a reduced atrium and a delicate ligamentous support, which connects the atrium and the paratergal tubercle.

7. The tracheal system is very simple and provided with a few tracheal anastomoses. The main longitudinal tracheal trunk is represented only by the dorsal intersegmental anastomoses throughout the entire length. The ventral intersegmental tracheal anastomoses are shown only between the metathorax and the first abdominal segment. The transverse anastomosis occurs only on the dorsal side of the cervical region, all the other commissures being reduced.

8. From each thoracic spiracle seven main tracheal stems arise and typically each abdominal segment is provided with five main tracheal stems. The distribution of these tracheæ is discussed in the text.

9. Throughout the entire length of the alimentary canal, the following regions, which fully correspond to those of the

typical digestive system of the insect, are noted: Basipharynx, œsophageal pump, œsophagus, cardiac valvula, stomach, pylorus, ileum, rectum, and salivary glands.

10. The development of the muscular layer and epithelial layer of the alimentary canal is very poor, especially in the region of the midintestine. Histologically there is no evidence of a digestive function, and probably the canal is reduced to a nonfunctional organ.

11. There are only two Malpighian tubes, which open into an unpaired, common, ventral, excretory chamber. Each tube consists of canaliculate cells, which are serially arranged in a row.

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ILLUSTRATIONS

PLATE 1. CROSS SECTIONS OF THE ALIMENTARY CANAL OF NYMPHOMYIA ALBA TOKUNAGA

FIG. 1. Œsophageal portion.
2. Cardiac portion.
3. Anterior portion of midintestine.
4. Pyloric portion.
5. Anterior portion of ileum.
6. Posterior portion of ileum.
7. Anterior portion of rectum through the intercalary part between ring muscles.
8. Anterior portion of rectum through ring muscle.
9. Malpighian tube.

bm, Basement membrane; *ch*, chitinous intima; *cm*, circular or ring muscle; *dep*, degenerated epithelium; *dn*, degenerated nucleus; *ic*, intracellular canaliculus; *iz*, inner zone; *n*, nucleus; *ne*, epithelial nucleus; *nm*, nucleus of muscle; *pg*, pigmental granule; *pm*, peritrophic membrane; *ptm*, peritoneal membrane; *sp*, sarcoplasma.

TEXT FIGURES

FIG. 1. Central nervous system of *Nymphomyia alba* Tokunaga. *A*, Arrangement of ganglia; *B* and *C*, dorsal and ventral aspects of supraœsophageal ganglion, showing metameric structure of neurospongium (cortical layer of ganglionic cells represented by black parts); *ag*, abdominal ganglion; *ann*, antennary nerve; *as*, abdominal segment; *cb*, central body; *ce*, compound eye; *cx*, calix; *dl*, deutocerebral lobe; *dpp*, middorsal lobe; *eo*, epiopticon; *fg*, frontal ganglion; *fl*, frontal lobe; *icp*, intercerebral part; *l*, leg; *mb*, mushroom body; *o*, opticon; *oc*, ocellus; *ol*, optic lobe; *pcb*, protocerebral lobe; *pl–ad*, anterior dorsal lobe; *pl–pd*, posterior dorsal lobe; *pl–pv*, posterior ventral lobe of protocerebrum; *po*, periopticon; *poc*, paraœsophageal connective; *sbg*, subœsophageal ganglion; *spg*, supraœsophageal ganglion; *thg*, thoracic ganglion; *tl*, tritocerebral lobe.

2. Spiracles of *Nymphomyia alba* Tokunaga. *A*, Metathoracic spiracle; *B*, diagrammatic structure of thoracic spiracle showing closing apparatus; *C*, vestigial spiracle of first abdominal segment; *cr*, direction of action of chitin ring; *ct*, ligamentous support; *ma*, direction of muscular action; *s*, spiracular chamber; *sm*, spiracular muscle; *sr*, closing spiracular chitin ring; *t*, paratergal tubercle; *tr*, trachea.

3. Tracheal system of *Nymphomyia alba* Tokunaga. *A*, Main tracheæ of head, thorax, and first abdominal segment; *B*, main tracheæ of ultimate four abdominal segments of male; *an*, antenna; *ce*,

compound eye; *hl*, halter; *l*, leg; *oc*, ocellus; *ps*, spiraclelike sensory pore; *s*, vestigial spiracle; *sp*, thoracic spiracle; *t*, paratergal tubercle; *wg*, wing; *1* to *22*, main tracheæ; *, transverse commissure.

FIG. 4. Digestive system and Malpighian tubes of *Nymphomyia alba* Tokunaga. *an*, Anus; *bx–op*, basipharynx; *ca*, cardia; *ec*, excretory chamber; *f–int*, fore intestine; *h–int*, hind intestine; *il*, ileum; *mc*, mouth cavity; mi_1 and *m–int*, middle intestine; *oe*, œsophagus; *op*, œsophageal pump; *py*, pylorus; *rc*, rectal constriction; *re*, rectum; *sg*, salivary gland; *1–8*, cross sections of alimentary canal illustrated in Plate 1.

5. Semidiagrammatic structure of Malpighian tube of *Nymphomyia alba* Tokunaga. *bm*, Basement membrane; *cc*, central canal; *ic*, intracellular canaliculus; *iz*, inner protoplasmic zone; *n*, nucleus; *pg*, pigment granule.

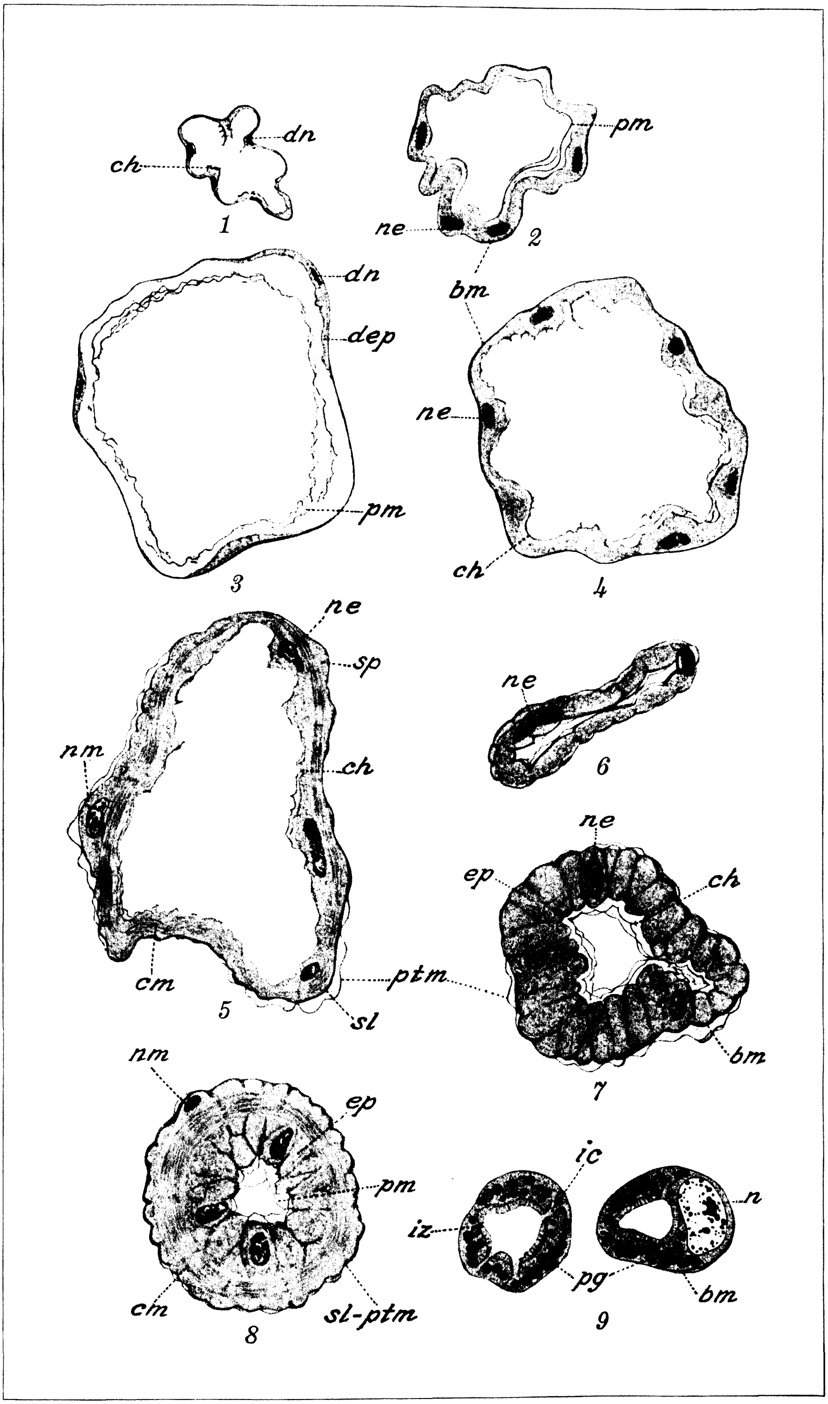
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PLATE 1.

NEW WHITE FLIES FROM THE PHILIPPINES AND FORMOSA (ALEYRODIDÆ; HEMIPTERA)

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ONE TEXT FIGURE

DIALEURODES (GIGALEURODES) PHILIPPINENSIS sp. nov.

Pupal case.—Brown in dried specimens, with no secretion evident. Very broad, subcircular, a little wider than long, broadest on the posterior part of cephalothorax, very broadly rounded on the anterior margin, broadly so on the hind margin, not constricted across the thoracic tracheal pores, not indented at the hind end, flattened, thin, without papillæ, ridges, or long setæ. Midthoracic suture thin, not reaching the margin; suture between the meso- and metanota not eminent; transverse suture between the thorax and abdomen thin, extending cephalad on the lateral part, nearly reaching the mesonotum, but not the margin of pupa case; abdominal segments discernible only on the narrow median area; rachis absent. Dorsum with many dense reticulations except on the narrow marginal area, many long thin lines running mesad from the margin, and many very small circular pores sparsely scattered except on the very narrow marginal area; about four pores scattered in an area of about 0.092 mm square; a pair of usual setæ near the vasiform orifice rather short; paler areas absent. Margin thin, with no distinct teeth, as in *Dialeurodes struthanthi* Hempel [1] with the usual two pairs of setæ rather short. Thoracic tracheal folds distinct, very long, narrow, gradually broadened towards the base, without sculptures, but with numerous minute dots, broadly sclerotized at the distal end along the pore, the sclerotized part nearly semilunar; thoracic tracheal pores small, closed, a little apart from the margin, directed laterally, without distinct teeth. Caudal furrow distinct, very long, narrow, much expanded at the base, not thickened on the lateral margin, reaching the anterior margin of vasiform orifice, with numerous polygonal sculptures, which are densely arranged in transverse

[1] Proc. U. S. Nat. Mus. **51**: pl. 72, fig. 3.

rows on the basal part and elongated on the small distal part; the distal pore like the thoracic tracheal pores. Ventral caudal fold much expanded anteriorly, with numerous minute dots. Vasiform orifice small, wider than long, rounded on the lateral and hind margins, thickened on the margin, not notched, without teeth, the anterior marginal area not well defined, not much expanded. Operculum wider than long, truncate on the hind margin, nearly filling the orifice. Lingula setose, usually not exposed.

Pupal case about 2.3 mm long, about 2.4 mm wide; vasiform orifice, including margin, about 0.074 mm wide; distance between vasiform orifice and hind end of pupal case about 0.53 mm; diameter of dorsal pore about 0.009 mm.

A few specimens were taken on an unknown tree imported from Manila, June 6, 1932, at the plant quarantine station, Takao, Formosa. This species resembles *Dialeurodes* (*Gigaleurodes*) *lithocarpi* Takahashi in th epupal case being wider than long, but differs from the latter in the pupal case being more rounded, the absence of paler areas on the dorsum, the structures of thoracic tracheal pores, and in other features.

DIALEURODES (RUSOSTIGMA) TRISTYLII Takahashi var. UICHANCOI var. nov.

Pupal case.—Differs from the typical form [2] in the following characters: Dorsum with larger circular pores sparsely scattered, eminent, and about 0.009 to 0.0095 mm in diameter; abdominal segments with no pair of markings along the anterior margin; vasiform orifice somewhat wider, more narrowed towards the hind end.

Pupal case about 1.66 mm long, 1.45 mm wide; vasiform orifice, including margin, about 0.065 mm wide.

A few specimens were collected on an undetermined tree imported from Manila, June 6, 1932, at the plant quarantine station, Takao, Formosa. Named for Prof. L. B. Uichanco, professor of entomology, College of Agriculture, Laguna, Luzon. In this variety, as in the typical form, the caudal furrow is a little narrower than the vasiform orifice; the vasiform orifice is very slightly notched at the hind end, with a very small median tooth close to the hind end and with about two, indistinct, minute marginal teeth, which are hardly discernible in some specimens; a pair of very short setæ is present near the base of

[2] Dept. Agr., Gov't. Res. Inst. Formosa, Rept. 66: 48.

the vasiform orifice; and the ventral tracheal folds bear numerous minute dots.

DIALEURODES CITRI Ashmead var. HEDERÆ var. nov.

Pupal case.—Differs from the typical form as follows: Dorsum sometimes with a narrow, longitudinal, blackish brown median patch, which reaches the vasiform orifice, but not the front margin of pupal case, and is sometimes interrupted on the thorax and abdomen; venter irregularly reticulated, with many rather large faint markings, mostly circular and with a broad border, scattered, except on the narrow marginal area.

Pupal case about 1.68 mm long, about 1.39 mm wide; diameter of ventral circular marking, including margin, about 0.32 mm; vasiform orifice about 0.046 mm long excluding anterior marginal area, about 0.06 mm wide including margin; distance between vasiform orifice and hind end of pupal case about 0.25 mm.

Hosts.—*Hedera formosana, Helicia* sp.

Habitats.—Formosa: Piyanan-ambu; Reimei, Hassensan; Rarasan near Urai; Izumo, Taito-cho.

Very abundant in the mountainous regions. Described from specimens taken by me on *Hedera formosana,* at Izumo, May 16, 1935. In some specimens collected on *Helicia* sp. at Rarasan, the dorsal patch is much wider. Differs from *Dialeurodes citri* Ashmead var. *kinyana* Takahashi in the much narrower dorsal patch and in the presence of more distinct, circular, ventral markings. In the variety *kinyana* Takahashi the ventral markings are mostly oval, with a distinct, longitudinal, darker area at the center. Easily distinguished from *Dialeurodes kirkaldyi* Kotinsky by possessing a median tooth in the vasiform orifice.

PEALIUS RUBI sp. nov. Text fig. 1.

Pupal case.—White, with a thin secretion along the margin. Elliptic, about 1.5 times as long as wide, not constricted, not indented at the hind end, a little convex on the dorsal disk, soft, asymmetrical in most specimens, with one to four irregular indentations on the margin. Midthoracic suture nearly reaching the margin; sutures between the thoracic segments distinct; transverse suture between the thorax and abdomen not reaching the margin; abdominal segments distinct, but the seventh and eighth not well defined. Dorsum without papillæ or distinct pores, but with many rather short thin lines run-

ning mesad from the margin; cephalothorax with three pairs of very long curved setæ, which are subequal in length and reach beyond the margin; a pair of similar setæ on the basal abdominal segment and another pair near the hind end; a short seta present laterad of the basal half of vasiform orifice; basal six abdominal segments with a pair of nearly oval markings

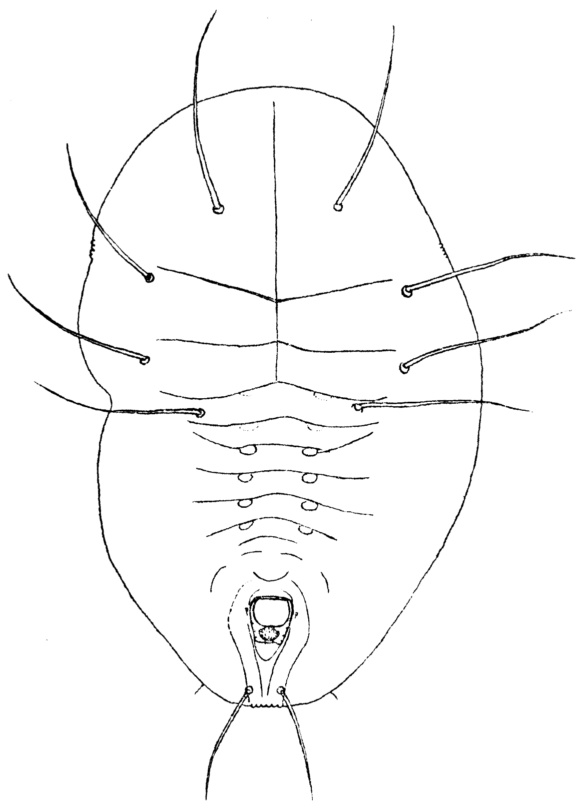

FIG. 1. *Pealius rubi* sp. nov., pupal case.

on the anterior part. Margin slightly sclerotized, with a pair of short usual setæ on the posterior part; marginal teeth very short, wide, much wider than long, broadly rounded on the distal margin, arranged in a row, about twelve or thirteen teeth occupying a space of 0.092 mm. Thoracic tracheal folds not discernible; combs with four or five teeth in a row, the teeth much narrower, but somewhat more sclerotized, than other marginal teeth, narrowed distally, rounded apically, and wider than long. Caudal furrow narrow, expanded basally, not distinct on the distal end, without distinct markings; comb with

about five teeth similar to those of the thoracic combs. Vasiform orifice large, nearly as long as wide, somewhat narrowed posteriorly, nearly straight or somewhat indented on the hind margin, a little shorter than the distance between the orifice and the hind end of pupal case, with a few very small pointed teeth on the lateral side; anterior marginal area expanded. Operculum wider than long, straight or very broadly rounded on the hind margin, occupying somewhat more than half the orifice. Ligula setose, knobbed, reaching or not the hind margin of the orifice, the knobbed part wider than long, with a very small lateral protuberance on the base and a pair of long apical setæ. Pit short, narrowed posteriorly, rounded apically, reticulated usually except on the median area. A pair of broad lobes surrounding the vasiform orifice and caudal furrow, reaching the margin.

Pupal case about 0.63 mm long, 0.42 mm wide; vasiform orifice, excluding anterior margin, about 0.048 mm long; distance between vasiform orifice and hind end of pupa case about 0.065 mm.

Host.—*Rubus* sp.

Habitat.—Formosa, Taihoku.

Some specimens were collected by me June 4, 1935. Allied to *Pealius polygoni* Takahashi, but differs in the presence of three pairs of longer and thinner setæ on the cephalothorax, the dorsal markings on the abdomen not distinctly radiating, and the larger vasiform orifice. Resembles *Aleurotrachelus rubi* Takahashi, differs in lacking longitudinal thoracic folds and a median ridge, the presence of a caudal furrow, the much shorter marginal teeth, the vasiform orifice being different in shape and not elevated, each pair of dorsal setæ being more widely separated from each other, and other characters.

The type specimens will be deposited in the Department of Agriculture, Government Research Institute, Formosa.

ILLUSTRATION

TEXT FIG. 1. *Pealius rubi* sp. nov., pupal case.

NEW OR LITTLE-KNOWN TIPULIDÆ FROM EASTERN ASIA (DIPTERA), XXIX [1]

By CHARLES P. ALEXANDER

Of Amherst, Massachusetts

TWO PLATES

The species of crane flies discussed below are chiefly from western China, where they were collected by the Rev. Mr. David C. Graham, the material being preserved in the United States National Museum. A second important series is from Japan, collected by Dr. Masaaki Tokunaga, the material being contained in my collection, with duplicates of the species being retained by Doctor Tokunaga. A few additional species from other sources are acknowledged in the text. My sincere thanks are extended to all parties who have thus contributed to this further study of the Asiatic Tipulidæ.

TIPULINÆ

TANYPTERA COGNATA sp. nov. Plate 1, fig. 1.

General coloration black, sparsely variegated by yellow; antennæ (male) unusually long, if bent backward extending to beyond base of abdomen; paired branches of flagellar segments long, approximately three times the long-oval unpaired outer branch; posterior femora elongate, black, the extreme base brightened; male hypopygium with dististyle small, dark-colored, narrowed into an acute apical point.

Male.—Length, about 14 millimeters; wing, 13.2.

Rostrum and palpi black. Antennæ black throughout; outer flagellar branch relatively short, long-oval, only about one-third the length of the basal paired branches; antennæ unusually long, if bent backward extending to beyond base of abdomen. Head black.

Pronotum yellow medially, darkened on sides. Mesonotal præscutum polished black, the humeral region restrictedly yellow; scutum, including median area, black, scutellum black, the parascutella obscure yellow; mediotergite black, its cephalic

[1] Contribution from the entomological laboratory, Massachusetts State College.

border yellow; pleurotergite chiefly yellow. Pleura dull black, the dorsopleural membrane obscure yellow. Halteres brownish black, the base of stem restrictedly pale. Legs with the coxæ black; trochanters obscure yellow; fore femora obscure yellow basally, the distal third or more passing into black; posterior femora black, only the bases narrowly pale; tibiæ and tarsi black; posterior femora and tibiæ unusually long. Wings (Plate 1, fig. 1) with a strong brownish yellow tinge; prearcular field narrowly clear yellow; stigma oval, brown; a scarcely evident brown wash on anterior cord; veins dark brown. Venation: R_{1+2} entire; R_3 rather strongly upcurved at extreme tip; petiole of cell M_1 longer than m; m-cu on M_4 just beyond origin.

Basal abdominal tergites yellow laterally, blackened medially; third and succeeding tergites uniformly blackened; sternites of basal half of abdomen yellow, the outer half black. Male hypopygium only moderately enlarged; dististyle small, dark-colored, narrowed to an acute apical point.

Habitat.—China (Szechwan).

Holotype, male, west of Yachow, altitude 2,000 to 7,500 feet, June 14 to 18, 1922 (*Graham*).

The nearest described allies of the present fly are *Tanyptera angustistyla* Alexander, of Japan, and *T. indica* (Brunetti), of the eastern Himalayan region. The former is readily told by the venation and the structure of the male hypopygium, especially the conformation of the outer dististyle. The latter species differs in the coloration of the thorax and abdomen. Both forms apparently have shorter antennæ, with the paired flagellar branches shorter in relation to the unpaired median one. The genus *Tanyptera* had not hitherto been recorded from China.

PSELLIOPHORA STABILIS sp. nov. Plate 1, fig. 2.

Size relatively small (wing, female, 14 millimeters); thorax and outer segments of abdomen uniformly and intensely blackened; head dark liver brown; basal four abdominal segments clear fiery orange; femora uniformly brownish black, with short setæ; posterior tibiæ slender, pale yellowish brown, the proximal fifth paler but not forming an evident ring; wings subhyaline or very faintly tinged with brown; stigma small, pale yellow, inconspicuous; Rs short.

Female.—Length, about 18 millimeters; wing, 14.

Frontal prolongation of head deep brown, short, with powerful nasus; palpi brown. Antennæ dark brown throughout, 10-seg-

mented, the outer flagellar segments becoming more globular; terminal segment pointed at apex, apparently formed by the fusion of two segments. Head uniformly dark liver brown.

Entire thorax black, only feebly nitidous to opaque. Halteres black, the base of stem narrowly paler. Legs with the coxæ dull black; trochanters brownish black; femora uniformly brownish black; tibiæ slender, pale yellowish brown, the basal fifth of the posterior pair more whitish but not forming any sort of a ring; tip of tibia weakly darkened; tarsi dark brown; femora with relatively short and inconspicuous setæ; hind tibiæ unusually slender. Wings (Plate 1, fig. 2) subhyaline or with a very faintly indicated brownish tinge; stigma small, pale yellow, scarcely differentiated; veins brown. Setæ of posterior border beyond squama long and conspicuous. Venation: Rs unusually short in relation to basal section of R_{4+5} being only slightly more than twice as long; R_2 short to punctiform; vein R_3 long-extended; m-cu at fork of M_{3+4}.

Abdomen with basal four segments, together with the very narrow cephalic border of the fifth tergite and the much more extensive corresponding portions of the fifth sternite, fiery orange, immaculate; remainder of abdomen, except tips of valves of ovipositor, black.

Habitat.—China (Yunnan).

Holotype, female, Psaotung (*Graham*).

In its general appearance, the present fly resembles a small *Pselliophora ctenophorina* Riedel or *P. speciosa* Edwards, but is readily told by the subhyaline wings and lack of a white ring on the tibiæ, including the posterior pair.

PSELLIOPHORA LAUTA sp. nov. Plate 1, fig. 3.

General coloration black, the præscutum with the lateral borders brightened; fore and middle femora yellow, posterior femora black, the tips narrowly yellow; tibiæ orange-yellow, with a vague, poorly defined, whitish ring close to base; wings dark brown, the narrow basal portion, costal border, and a cross-band before cord yellow; abdominal tergites ringed yellow and black, the apices of the latter color.

Female.—Length, about 19 millimeters; wing, 15.

Rostrum and palpi black, the terminal segment of the latter elongate. Antennæ with the scape and pedicel black, flagellum brownish black to brown, the segment oval, sessile. Head velvety black.

Pronotum velvety black. Mesonotum black, the intermediate præscutal stripes more reddish; lateral borders of præscutum between the humeral region and suture conspicuously reddish yellow. Pleura black throughout. Halteres black. Legs with the coxæ and trochanters black, the apices of the latter narrowly brightened; fore and middle femora yellow; posterior femora black, the apices narrowly yellow; tibiæ orange-yellow, with a very ill-defined more whitish yellow ring near base; tarsi broken. Wings (Plate 1, fig. 3) with the ground color rather dark brown, conspicuously variegated by yellow, the latter color including the prearcular region, very narrow bases of cells R to 2d A, inclusive, and almost all of cells C and Sc, the outer ends of the latter being darkened; an arcuated yellow crossband extending across wing from stigma to outer end of cell Cu, traversing the outer ends of cells R and M just before their extreme tips; a yellow spot in outer end of cell 1st A; all cells beyond cord uniformly darkened; extreme wing base darkened; postsquamal setæ long and conspicuous; veins brown in the darkened areas, more yellowish where traversing yellow areas. Venation: Cell M_1 narrowly sessile; cell M_4 narrowed at margin.

Abdomen with basal tergite velvety black; succeeding tergites with bases yellow, the apices black, the amount of the latter color increasing outwardly until on the seventh tergite only the lateral basal angles are brightened; outer tergite uniformly darkened; second and third sternites very extensively yellow, the outer sternites patterned about as on the corresponding tergites.

Habitat.—China (Szechwan).

Holotype, female, Fulin, altitude 3,000 to 7,000 feet, August 18 to 21, 1928 (*Graham*).

The most closely allied species are *Pselliophora bifasciipennis* Brunetti and *P. fumiplena* (Walker), which have a very different leg pattern. The possibility is not excluded that the present fly may be only subspecifically distinct from *fumiplena*, but it certainly appears to represent a valid species.

DICTENIDIA LUTEICOSTALIS sp. nov. Plate 1, fig. 4.

General coloration yellow, the mesonotal præscutum with an elongate, median, wedge-shaped, blackened mark, the long point directed backward; femora yellow; posterior tibiæ enlarged, yellow, the narrow tips and broader ring on basal half black;

wings strongly suffused with yellow, especially the wide costal border, the disk almost immaculate; veins black; macrotrichia in outer ends of cells R_3 to M_1, inclusive; abdomen orange-yellow, the tergites with a narrow, interrupted, median vitta on the basal four segments.

Female.—Length, about 14 millimeters; wing, 12.

Frontal prolongation of head yellow, without clearly defined nasus, the outer end more dusky; palpi yellow, the elongate terminal segment a trifle darkened at outer end. Antennæ chiefly yellow, the scape and outer edges of flagellar serrations more dusky; antennæ 11-segmented, the six intermediate flagellar segments moderately produced on ventral face, the serrations truncate or subtruncate; terminal two segments closely approximated or fused, the last pointed. Head yellow, the anterior vertex with a transverse brown fascia extending from eye to eye, the color continued backward to occiput as a median line.

Pronotum narrow, chiefly infuscated. Mesonotal præscutum polished yellow, with three more reddish yellow stripes, the median one on cephalic portion replaced by an elongate-triangular black wedge, the long point directed behind; posterior sclerites of mesonotum uniformly reddish yellow. Pleura yellow, conspicuously variegated by more reddish areas on the anepisternum. Halteres yellow, the knobs infuscated, the extreme tips slightly paler. Legs with the coxæ and trochanters yellow; forelegs broken; middle legs with femora and tibiæ uniformly yellow; basitarsi brownish black, the remainder of tarsi black; posterior legs with femora uniformly yellow; tibiæ longer and stouter, rather conspicuously arcuated, with long conspicuous setæ; yellow, the tip narrowly black and with a broader black ring occupying the outer end of the basal half; tarsi black. Wings (Plate 1, fig. 4) strongly suffused with yellow, virtually immaculate except for the small brown stigma; narrow and insensibly indicated seams along cord and the wing apex extensively but very slightly infumed; cells R and M a trifle more tinged with brown, the latter with a central pale streak in outer third; cells C, Sc, and Cu_1 more intensely saturated yellow; veins black, conspicuous, the prearcular veins, together with C, Sc, and R, yellow. Rather numerous but small macrotrichia in outer ends of cells R_3, R_5, and M_1, inclusive. Venation: Petiole of cell M_1 subequal to m; cell 1st M_2 small, pentagonal.

Abdomen orange-yellow, the tergites with a narrow, slightly interrupted, median black stripe on basal four segments, the line becoming narrower and more attenuated behind; lateral borders of tergites slightly paler, margined internally by dusky; sternites unmarked. Ovipositor with both cerci and hypovalvæ compressed and with tips obtuse or truncated, the hypovalvæ much shorter.

Habitat.—China (Szechwan).

Holotype, female, between Chengtu and Mowchow, altitude 1,400 to 4,500 feet, July 3 to 10, 1924 (*Graham*).

Despite the fact that the present species is known only from the female sex, I feel certain that the generic reference is correct. The venation and presence of numerous macrotrichia in the apical wing cells is much as in all other known species of the genus, with the exception of the aberrant *Dictenidia inæquipectinata* Alexander, of the high mountains of Formosa. The very strongly yellowish wings and the coloration of the body will serve to separate the present fly from its other relatives in eastern Asia. The genus is new to the fauna of China.

TIPULA (OREOMYZA) CLADOMERA sp. nov. Plate 1, fig. 5; Plate 2, figs. 25, 26.

General coloration brown, pruinose, the præscutum with four brown stripes; antennæ (male) extending nearly to base of abdomen; flagellar segments black, their apices narrowly pale; femora brownish yellow, the tips narrowly blackened; claws (male) toothed; wings pale brown, restrictedly variegated by paler areas before and beyond stigma and across cord; male hypopygium with the outer dististyle very large and of unusual shape, expanded outwardly, the apex with a U-shaped notch to form two conspicuous lobes; eighth sternite with nine or ten very coarse setæ on either side of midline of caudal margin.

Male.—Length, about 15 millimeters; wing, 14.5.

Frontal prolongation of head reddish brown; nasus long and powerful; palpi brownish black. Antennæ moderately long, if bent backward extending nearly to base of abdomen; scape and pedicel light yellow; first flagellar segment light brown, paler at tip; succeeding flagellar segments black, their apices narrowly pale; flagellar segments weakly incised; verticils subequal in length to the segments. Head reddish brown, with a narrow brownish median vitta on vertex, becoming narrower and more attenuated behind.

Mesonotal præscutum brown, pruinose with gray, apparently with four brown stripes that are bordered by darker, this region of body badly discolored in type; scutum brownish gray, the lateral portions darker; scutellum and mediotergite gray with a capillary brown median vitta. Pleura chiefly gray. Halteres pale yellow, the knobs infuscated, with their tips restrictedly pale. Legs with the coxæ brownish gray; trochanters obscure yellow; femora brownish yellow, the tips narrowly blackened, preceded by a vague, clearer yellow ring; tibiæ brown, the tips narrowly blackened; tarsi reddish brown; tibial spur formula 1–2–2; claws (male) toothed. Wings (Plate 1, fig. 5) with a pale brown tinge, cell Sc somewhat darker; stigma small, brown; very restricted paler areas before and beyond stigma and across cell 1st M_2; a more or less distinct brown seam along vein Cu in cell M; veins brown. Venation: R_{1+2} long, entire, with macrotrichia on basal fourth; cell 1st M_2 small, pentagonal.

Basal abdominal tergites yellow, lined with darker; hypopygium yellow. Male hypopygium (Plate 2, fig. 25) with the suture between tergite, 9*t*, and sternite, 9*s*, short. Basistyle at apex produced into a flattened lobule. Ninth tergite (Plate 2, fig. 26, 9*t*) short, entirely pale, with pale setæ; caudal margin with a narrow, U-shaped, median notch that extends fully to midlength of the sclerite; the broad lateral lobes obliquely truncated. Outer dististyle (Plate 2, fig. 26, *od*) very large and of unusual shape, being expanded outwardly and deeply bifid by a U-shaped apical notch; margins of lobes darkened and sclerotized. Inner dististyle (Plate 2, fig. 26, *id*) much smaller, as shown by the figures. Eighth sternite broadly and shallowly notched, the median area with restricted pale membrane, the margin on either side of midline with nine or ten long, unusually coarse setæ, the more lateral ones smaller.

Habitat.—China (Szechwan).

Holotype, male, Wan-hsien, September 14, 1921 (American Museum of Natural History, accession No. 23974).

The very remarkable male hypopygium will serve to separate this species from all others in the genus described to this date. I have compared the fly with my almost complete series of species of this particular faunal area and can find no form with which it may be profitably compared. The great size and unusual conformation of the outer dististyle of the male hypopygium is different from the normal condition in *Oreomyza*, but I believe the species to be correctly referred to this subgenus.

LIMONIINÆ

LIMONIINI

LIMONIA (LIMONIA) ARTHRITICA sp. nov. Plate 1, fig. 6.

General coloration of thorax green, the præscutum with three orange stripes; head orange; legs yellowish white, the femoral tips strongly swollen and blackened; all tarsi white, the three outer segments pale brown; wings long and narrow, rich brown, the outer margin in radial field deeper brown; a restricted darker brown pattern on certain of the veins and crossveins; Rs very elongate, angulated at origin; cerci small, slender, strongly upcurved.

Female.—Length, about 5.5 millimeters; wing, 7.5.

Rostrum short, polished black; palpi black. Antennæ with scape and pedicel intense black; flagellum dull black, the proximal ends of the segments indistinctly and vaguely paler; flagellar segments oval to long-oval. Head fiery orange.

Pronotum green. Mesonotal præscutum green, with three orange stripes that are nearly confluent, the interspaces indicated only by delicate vittæ of the ground color; scutum green, the lobes variegated by orange; scutellum and mediotergite green. Pleura strongly suffused with green, presumably fading to yellow in older specimens. Halteres obscure brownish yellow, the knobs infuscated. Legs with the coxæ and trochanters greenish; femora yellowish white, the tips very strongly swollen and heavily blackened, the degree of incrassation and blackening subequal on all legs; tibiæ yellow, the extreme bases blackened, the tips broadly blackened, the amount of the latter involving approximately the distal fifth; all tarsi with basal two segments snowy white, the outer segments pale brown, with segments three and four weakly swollen. Wings (Plate 1, fig. 6) long and narrow, with slender basal petiole; ground color strongly rich brown, the margin in outer radial field suffused with dark brown; restricted darker brown spots and clouds, arranged as follows: Origin of Rs; fork of Sc; free tip of Sc_2 and R_2; cord and outer end of cell 1st M_2; veins pale, somewhat darker in the clouded areas. Macrotrichia of veins beyond cord abundant and well distributed. Axillary angle of wing just beyond squama strongly dilated. Venation: Sc moderately long, Sc_1 ending just before midlength of Rs, Sc_2 close to its tip; Rs very long, angulated at origin; free tip of Sc_2 lying some distance before R_2, the latter gently curved into R_1, with no sign of a spur of R_{1+2}; inner end of cell 1st M_2 strongly arcuated; m at beyond one-third the

length of the cell; veins M_{1+2} and M_3 exceeding cell 1st M_2 in length; m-cu at or just before the fork of M; anal veins parallel or very gently divergent at origin.

Abdominal tergites brown, the sternites more greenish yellow; terminal segments more buffy. Ovipositor with the cerci much shorter than the hypovalvæ, slender, strongly upcurved.

Habitat.—Java (west).

Holotype, female, Goenoeng Tjimerang, Djampangs, March, 1935 (*M. E. Walsh*); in author's collection.

The present fly is so different from all other members of the subgenus yet described that comparison with any other species would be unprofitable. The strongly swollen and blackened tips of all femora give to the insect a very strange appearance. It is very probable that the rich green tints of the thorax will fade to yellow or greenish yellow in old specimens.

LIMONIA (LIMONIA) NOMINATA sp. nov.

General coloration of præscutum black, with three reddish brown stripes; pleura almost uniformly darkened; apices of knobs of halteres yellow; femora yellow, the distal end, including apex, blackened, inclosing a narrow yellow ring; wings cream-yellow, very extensively clouded by brown washes that restrict the ground color to narrow, broken, chiefly transverse bands; Sc_2 ending before level of fork of Rs; R_{1+2} shorter than R_{2+3}; cell 1st M_2 relatively small; m-cu beyond the fork of M; abdominal tergites bicolorous, black, the bases of the segments narrowly yellow.

Female.—Length, about 12 millimeters; wing, 12.5.

Rostrum and palpi black. Antennæ brownish black throughout; flagellar segments elongate, the longest verticils somewhat exceeding the segments. Head brownish black.

Pronotum dark brown above, paler on sides. Mesonotal præscutum with the ground color black, with three reddish brown stripes; scutal lobes chiefly blackened, the median region restrictedly pale; scutellum reddish brown; mediotergite dark. Pleura almost uniformly dark brown or brownish black. Halteres relatively long, yellow, the basal half of knob dark brown. Legs with the fore and middle coxæ dark brown, the posterior coxæ paler; trochanters obscure yellow; femora yellow, the tip and a subterminal ring blackish, the two latter inclosing a yellow annulus that is a little more extensive than the darkened apex and much narrower than in the allied *prudentia;* tibiæ and

tarsi brown. Wings with the ground color cream-yellow, chiefly concealed by unusually extensive brown clouds and washes, restricting the ground to broken transverse bands beyond the arculus, at middistance between the latter and origin of Rs, beyond the origin of Rs and a long cord; small isolated spots of the ground before and beyond the stigma, near outer end of cell 1st M_2, outer end of cell 2d M_2, and as a spot at near midlength of cell 2d A; cell Cu_1 almost uniformly darkened; veins brown, more yellowish in the ground areas. A series of macrotrichia distributed over almost the whole length of vein Rs, lacking on the basal ascending portion. Venation: Sc relatively short, Sc_2 ending some distance before the fork of Rs, in *prudentia* slightly beyond this fork; Sc_1 shortly removed from the tip of Sc_2; R_{1+2} elongate but shorter than R_{2+3}; cell 1st M_2 small, shorter than the veins issuing from it; m-cu about one-third to one-fourth its length beyond the fork of M.

Abdominal tergites black, the incisures narrowly yellow, including the bases of the sclerites; basal sternites yellow, the outer segments bicolorous, black and yellow, the bases of the latter color. Cerci small and slender.

Habitat.—China (Szechwan).

Holotype, female, Wen Chuan, November 15 to December 5, 1934 (*Graham*).

The nearest allied species appears to be *Limonia* (*Limonia*) *prudentia* Alexander, likewise from western China, which has the leg pattern somewhat similar but with the wing pattern and venation quite distinct.

LIMONIA (DICRANOMYIA) PENITA sp. nov. Plate 1, fig. 7; Plate 2, fig. 27.

Belongs to the *morio* group; size relatively large (wing, male, 8 millimeters); halteres dusky, the base of stem narrowly pale; vein 2d A longer than in *paramorio* but much shorter than in *kongosana;* abdomen black, the posterior portions of the intermediate sternites paler; male hypopygium with the tergal lobes slender; ventromesal lobe of basistyle very broad and obtuse; apex of dorsal dististyle acute; ventral dististyle oval, the rostral prolongation long and slender, subequal in length to the rostral spine.

Male.—Length, about 7.5 millimeters; wing, 8.

Rostrum and palpi black. Antennæ black throughout; flagellar segments long-oval, with short apical pedicels. Front conspicuously silvery white; posterior region of head dull brownish black.

Thoracic dorsum polished black, the posterior sclerites a trifle more pruinose. Pleura rather heavily dusted with gray. Halteres elongate, dusky, the base of stem narrowly paler. Legs with the fore coxæ black, remaining coxæ more brownish yellow; trochanters obscure yellow; femora obscure yellow, the tips narrowly and weakly darkened; remainder of legs dark brown to brownish black. Wings (Plate 1, fig. 7) strongly tinged with brown, the stigma still darker brown; veins brown. Venation: Sc_1 ending a short distance beyond origin of Rs, Sc_2 far removed from its tip, Sc_1 alone subequal in length to Rs; free tip of Sc_2 and R_2 in approximate transverse alignment; m-cu shortly before fork of M; vein 2d A elongate.

Abdomen black, the apical portions of the intermediate sternites vaguely paler. Male hypopygium (Plate 2, fig. 27) with the lobes of the tergite, *9t*, moderately stout, but considerably narrower than the width of the U-shaped emargination separating them. Ventromesal lobe of basistyle, *b*, very broad and obtuse, its apex rounded. Dorsal dististyle a slender, gently curved, blackened rod, gradually narrowed to the acute tip. Ventral dististyle, *vd*, of moderate size, pale, oval in outline, the rostral prolongation dusky, slender; a single stout pale spine that is subequal in length to the rostral prolongation beyond its insertion.

Habitat.—China (Szechwan).

Holotype, male, Wen Chuan, November 15 to December 5, 1934 (*Graham*).

The nearest allies of the present fly are *Limonia* (*Dicranomyia*) *kongosana* Alexander, of Korea, and *L.* (*D.*) *paramorio* (Alexander), of Japan and eastern China, both of which have the dorsal dististyle acute at apex, the rostral prolongation of the ventral dististyle evident, and the ninth tergite more or less produced into lobes. The present insect is about intermediate in its characters between the indicated species but is amply distinct in the details of the hypopygium.

LIMONIA (RHIPIDIA) ISOSPILOTA sp. nov. Plate 1, fig. 8.

Allied to *maculata;* general coloration (in spirit) dark, the thoracic pleura distinctly striped longitudinally with dark; wings whitish subhyaline, the entire surface abundantly dotted with brown and grayish brown, the latter covering most of disk and being subequal in area to the interspaces; darker costal areas of small size, the spot at end of Sc widely separated from the one at origin of Rs; Sc_1 at or beyond midlength of Rs.

Female.—Length, about 7 to 7.5 millimeters; wing, 5.5 to 6.

Described from alcoholic specimens.

Rostrum and palpi black. Antennæ brownish black, the apical pedicels of the flagellar segments white; flagellar segments moderately produced (female). Head grayish brown.

Mesonotum uniformly darkened, in fresh specimens probably pruinose; lateral portions of præscutum paler. Pleura narrowly lined with still darker, appearing as longitudinal stripes across the ventral anepisternum and ventral sternopleurite. Halteres pale. Legs with the coxæ darkened; trochanters pale; remainder of legs dark brown, the femoral bases a little brightened. Wings (Plate 1, fig. 8) whitish subhyaline, the entire surface abundantly dotted with brown or paler grayish brown areas, of which the former are subequal in size to the latter; none of the darkenings of large size, as is the case in *maculata* and allies; dark spots at tip of Sc_1 and origin of Rs widely separated; stigmal area and clouds at fork of Rs and along m-cu slightly larger; dots in the cells almost equal in area and comparable to the pale interspaces; veins yellowish brown, darker in the clouded areas. Venation: Sc long, Sc_1 ending at or beyond midlength of Rs, Sc_2 at its tip; m-cu approximately one-half its length before the fork of M.

Abdomen relatively pale brown.

Habitat.—Japan (Honshiu).

Holotype, alcoholic female, Kibune, Kyoto, October 16, 1934 (*Tokunaga*). Paratopotype, alcoholic female.

Limonia (*Rhipidia*) *isospilota* is most readily told from *L.* (*R.*) *maculata* (Meigen) by the unusually long Sc, with the darkened area at its tip widely separated from that at origin of of Rs; from *L.* (*R.*) *triarmata* Alexander it is told by the elongate Sc, which ends opposite or beyond midlength of Rs.

LIMONIA (RHIPIDIA) HYPOMELANIA sp. nov. Plate 1, fig. 9; Plate 2, fig. 28.

Mesonotum and pleurotergite pale yellowish brown, contrasting abruptly with the blackened ventral pleurites and sternum; antennæ (male) with eight bipectinate segments; femora yellow, the bases weakly darkened; wings pale yellow, with very abundant pale brown dots in the cells; Sc relatively long, Sc_1 ending beyond one-third the length of Rs; male hypopygium with five or six long curved spines placed far out near apex of rostral prolongation.

Male.—Length, about 6.5 to 7 millimeters; wing, 7.5 to 8.

Female.—Length, about 7.5 millimeters; wing, 8.

Male.—Rostrum and palpi black. Antennæ with eight bipectinate segments (flagellar segments two to nine, inclusive); scape and pedicel black; flagellar segments with basal enlargements and branches black, the long apical pedicel yellow; longest branches (about flagellar segments four to six) approximately one-half longer than the segment; first flagellar segment merely produced; flagellar segments ten and eleven with a single branch, on the former segment nearly as long as the enlargement; terminal segment about one-half longer than the penultimate. Head black, pruinose, paler behind.

Mesonotum almost uniformly pale yellowish brown, this color including the dorsopleural region and pleurotergite, contrasting abruptly with the blackened propleura, anepisternum, sternopleurite, sternum, and meral region. Halteres pale yellow, the knobs weakly darkened. Legs with the coxæ blackened; trochanters brownish black; femora yellow, the bases weakly darkened; tibiæ and tarsi yellow, the terminal segments of the latter passing into black. Wings (Plate 1, fig. 9) pale yellow, with abundant, very pale brown dots in the cells, these so indistinct as to make the wing appear virtually unicolorous; similar sized but slightly darker dots at the supernumerary crossvein in cell Sc, origin of Rs, fork of Sc, along cord, and on outer end of cell 1st M_2; veins yellow, a little darker in the clouded areas. Venation: Sc relatively long, Sc_1 ending beyond one-third the length of Rs, Sc_2 at its tip; m-cu slightly variable in position in different specimens, from immediately before fork of M to nearly one-half its length before this point.

Abdomen yellowish brown. Male hypopygium (Plate 2, fig. 28) with the caudal margin of tergite, *9t,* almost evenly, convexly rounded. Basistyle, *b,* with the ventromesal lobe broad, with abundant setæ. Dorsal dististyle nearly straight, a little expanded at apex, suddenly narrowed to an apical spine. Ventral dististyle, *vd,* of moderate size, the rostral prolongation long, with five or six long curved spines placed far out near apex.

Female.—Characters as in male, differing only in the sexual features. Flagellar segments simply produced on ventral face.

Habitat.—China (Szechwan).

Holotype, male, Mount Omei, altitude 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*). Allotopotype, female, in fragmentary condition, altitude 11,000 feet, August 18, 1934 (*Graham*). Paratopotype, male, with the allotype.

The present fly is very distinct from all other regional species of the subgenus, especially in the peculiar pattern of the thorax and in the weakly patterned wings.

ANTOCHA (ANTOCHA) SPICATA sp. nov. Plate 1, fig. 10; Plate 2, fig. 29.

Size small (wing, about 4 to 5 millimeters); general coloration dark; halteres pale; wings grayish, the prearcular field paling to white; veins pale brown, contrasting but little with the ground; vein Sc short; male hypopygium with both dististyles simple; outer gonapophysis bluntly rounded at apex.

Male.—Length, about 3.5 to 4 millimeters; wing, 4 to 5.2.

Described from alcoholic specimens.

Rostrum and palpi brown. Antennæ with the scape brown, the pedicel and flagellum darker brown; flagellar segments subglobular to very short-oval, the outer segments slightly more elongate. Head dark brown.

Thorax almost uniformly darkened (in spirit), undoubtedly pruinose in fresh specimens; præscutal stripes not clearly evident. Halteres pale. Legs with the coxæ and trochanters brown; remainder of legs uniformly darkened. Wings (Plate 1, fig. 10) with a grayish tinge, the prearcular field paling to white; veins pale brown, contrasting but little with the ground. Venation: Sc short; as in *brevinervis*, Sc_1 ending about opposite two-thirds to three-fourths the length of Rs; r-m at or before one-third the length of cell 1st M_2; m-cu before the fork of M.

Abdomen, including hypopygium, uniformly dark brown. Male hypopygium (Plate 2, fig. 29) with the tergite, *9t*, transverse, the posterior border emarginate medially. Basistyle, *b*, with a setiferous lobe on mesal face at base; setæ of outer face at apex longer and more powerful. Both dististyles, *d*, simple and of generally similar outline, the tip of the outer or glabrous style a trifle more pointed. Ædeagus, *a*, notched at apex. Inner gonapophyses, *g*, appearing as straight simple spikes; outer apophyses shorter, ending in obtuse flattened blades.

Habitat.—Japan (Hokkaido, Honshiu, Kiushiu).

Holotype, alcoholic male, Kibune, Kyoto, Honshiu, October 11, 1934 (*Tokunaga*). Paratypes, 1 male, Date, Iburi, Hokkaido, September 4, 1923 (*S. Kuwayama*); 1 male, Jozankei, Ishikari, Hokkaido, August 19, 1922 (*T. Esaki*); 1 male, Takaharu, Hiuga, Kiushiu, November 1, 1923 (*T. Esaki*). Types in author's collection.

The nearest described ally is *Antocha* (*Antocha*) *brevinervis* Alexander, which has the subcostal vein similarly abbreviated and likewise agrees in its general appearance. The present fly is most readily told by its small size, whitened wing bases, pale wing veins, and differences in the conformation of the ædeagus and outer gonapophyses. In the original definition of *brevinervis*,[2] the present species was confused in the type series; the true holotype of *brevinervis* being from Sapporo, Hokkaido, June 25, 1921, collected by Kuwayama.

ORIMARGA (ORIMARGA) DISTALIS sp. nov. Plate 1, fig. 11; Plate 2, fig. 30.

Mesothorax dark brown; wings uniformly pale yellow, the veins a trifle darker; macrotrichia of veins beyond cord relatively numerous; R_{2+3} about twice R_{1+2}; M_{3+4} a little longer than M_4; m-cu lying unusually far distad, approximately two or two and one-half times its own length before the fork of M and opposite the distal end of Rs; spines at apex of ædeagus long and needlelike.

Male.—Length, about 7.5 millimeters; wing, 6.

Described from an alcoholic specimen.

Rostrum, palpi, and antennæ dark brown; flagellar segments oval, the terminal segment smaller than the penultimate. Head dark brown; anterior vertex about equal to twice the diameter of the scape.

Pronotum elongate, pale brown. Mesonotum (in spirit) uniformly dark brown, without clearly defined markings excepting the slightly brightened humeral region and a very ill-defined, capillary, median pale vitta that extends almost the entire length of the mesonotum. Pleura brown. Halteres white throughout. Legs with the coxæ and trochanters yellowish brown; remainder of legs uniformly brown. Wings (Plate 1, fig. 11) with a uniform pale yellow tinge; veins yellowish brown; costal fringe relatively short; macrotrichia of veins beyond cord relatively numerous, including outer ends of veins R_{1+2} to Cu_1, inclusive. Venation: Sc_1 ending shortly before the fork of Rs; R_{2+3} about twice R_{1+2} alone; free tip of Sc_2 distinct; R_1 a little shorter than R_{1+2}; M_{3+4} a little longer than M_4; m-cu lying unusually far distad, approximately two to two and one-half times its own length before the fork of M and opposite the distal end of Rs.

[2] Philip. Journ. Sci. 24 (1924) 567.

Abdomen brown, the sternites a little brighter. Male hypopygium (Plate 2, fig. 30) with the paired spines at apex of ædeagus, *a*, long and needlelike; inner gonapophyses, *g*, unusually narrow, weakly notched at tips.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Mount Daisen, Hoki, July 2, 1931 (*Tokunaga*).

Orimarga (*Orimarga*) *distalis* is readily distinguished from the other Japanese species of the genus having vein R_{2+3} elongate, by the position of m-cu, which lies far distad, opposite the outer end of Rs. In all other species of this group so far described from China and Japan, m-cu lies three or more times its own length before the fork of M and opposite or before midlength of Rs. The most nearly allied single species is *O.* (*O.*) *yakushimana* Alexander (Kiushiu, Honshiu), which has the inner gonapophyses of the male hypopygium unusually broad, with their apices entire.

HELIUS (HELIUS) LONGINERVIS Edwards.

Helius longinervis EDWARDS, Journ. Fed. Malay States Mus. 14 (1928) 87–88.

Described from a unique male taken at Cameron's Highlands, Pahang, altitude 4,800 feet, March 13, 1924.

One male, Tjibodas, western Java, altitude 4,200 feet, February 4, 1934 (*M. E. Walsh*); in author's collection.

LECHRIINI

TRICHONEURA (XIPHOLIMNOBIA) JAVANENSIS sp. nov. Plate 1, fig. 12.

General coloration dark brown; head silvery gray; extreme lateral border of præscutum narrowly silvery; pleura with a narrow, pale, longitudinal stripe; legs brown; wings with a strong brown tinge; Rs about one-fifth longer than R.

Female.—Length, about 3.5 millimeters; wing, 3.2.

Rostrum and palpi black. Antennæ black throughout; flagellar segments oval to long-oval, with long conspicuous verticils. Head clear silvery gray.

Mesonotum uniformly dark brown, the extreme lateral border of præscutum more silvery. Pleura dark brown, with a poorly defined, pale, longitudinal stripe extending from behind the fore coxæ, across the dorsal sternopleurite, to the abdomen, passing above the fore coxæ. Halteres dusky. Legs with the coxæ and trochanters dark brown; remainder of legs brown. Wings (Plate 1, fig. 12) with a strong brownish tinge; stigma lack-

ing; veins darker brown. Macrotrichia of veins more restricted than in *bontocensis,* there being only two or three at extreme distal end of Rs and none on the main stem of M. Venation: Sc_1 ending about opposite four-fifths the length of Rs, Sc_2 close to its tip; Rs of moderate length, about a fifth longer than R; m-cu a little less than its own length before fork of M_{3+4}.

Abdomen dark brown; valves of ovipositor very long and straight, as in the subgenus.

Habitat.—Java (west).

Holotype, female, Soekaboemi, altitude 1,800 feet, January, 1934 (*M. E. Walsh*); in author's collection.

By my key to the Asiatic species of *Xipholimnobia* [3] the present species runs to *Trichoneura* (*Xipholimnobia*) *bontocensis* Alexander (Luzon), which seems undoubtedly to be its nearest ally. The present species differs in the details of coloration and the more-restricted trichiation of the wing veins.

PEDICIINI

DICRANOTA (RHAPHIDOLABIS) TUBERCULATA sp. nov. Plate 1, fig. 13.

General coloration reddish brown, the præscutum with a single median brown stripe; pleura reddish brown; pronotum with a small median tubercle on the cephalic border; knobs of halteres weakly darkened; wings pale grayish subhyaline, unmarked except for the yellowish brown stigma.

Female.—Length, about 6 millimeters; wing, 5.5.

Described from alcoholic specimens.

Rostrum brown; palpi dark brown. Antennæ black throughout, 13-segmented; flagellar segments oval. Head dark, probably pruinose in fresh specimens.

Pronotum dark brown, with a conspicuous, erect, median tubercle on cephalic border. Mesonotal præscutum gibbous, reddish brown, with a single median brown stripe that becomes obsolete before the suture. Pleura uniformly reddish brown. Halteres pale, the knobs weakly darkened. Legs with the coxæ reddish brown; trochanters paler; remainder of legs broken. Wings (Plate 1, fig. 13) pale grayish subhyaline, unmarked except for the pale yellowish brown stigma; veins pale brown, with abundant macrotrichia. Venation: Rs straighter and somewhat longer than in *consors;* R_{2+3+4} moderately long, subequal to m-cu; R_2 considerably exceeding R_{1+2}; m-cu nearly its own length beyond the fork of M.

[3] Philip. Journ. Sci. 53 (1934) 440.

Abdomen light brown; valves of ovipositor horn yellow.

Habitat.—Japan (Honshiu).

Holotype, alcoholic female, Kibune, Kyoto, October 11, 1934 (*Tokunaga*). Paratopotype, female.

The nearest described ally of the present fly is *Dicranota* (*Rhaphidolabis*) *consors* (Alexander), likewise from Japan, which agrees in the nearly immaculate wings with vein R_{2+3+4} preserved, differing in the 12-segmented antennæ, the lack of a pronotal tubercle, and the coloration of the thorax.

DICRANOTA (RHAPHIDOLABIS) BILOBA sp. nov. Plate 1, fig. 14; Plate 2, fig. 31.

General coloration dark gray, the præscutum with three more blackish stripes; pleura heavily gray pruinose; antennæ 15-segmented, black throughout; halteres with darkened knobs; legs black, the femoral bases restrictedly brightened; wings tinged with gray, the prearcular field conspicuously light yellow; stigma and seams along cord and distal half of vein Cu_1 weakly infuscated; R_{2+3+4} longer than basal section of R_5; male hypopygium with the extensive tergite profoundly bilobed by a narrow U-shaped median notch, the lobes with obtuse lateral shoulders before apices.

Male.—Length, about 7 millimeters; wing, 8.5.

Rostrum and palpi black. Antennæ black throughout, 15-segmented, short; flagellar segments beyond the elongate first one oval, becoming smaller and more crowded at outer end. Head dark gray.

Pronotum and mesonotum dark gray, the præscutum with three more blackish stripes, the lateral pair crossing the suture onto the scutal lobes. Pleura heavily gray pruinose. Halteres with stem pale yellow, the knob dark brown. Legs with the coxæ pruinose; trochanters dark brown; remainder of legs long and slender, black, the femoral bases restrictedly paler. Wings (Plate 1, fig. 14) tinged with gray, the prearcular field conspicuously light yellow; costal region less conspicuously brightened; stigma and seams along cord and distal half of vein Cu_1 weakly infuscated; veins brown, yellow in the flavous areas. Venation: R_{2+3+4} from one-half longer to approximately twice the basal section of R_5, the latter subequal to r-m; cell M_1 approximately one-half as deep as cell M_3.

Abdomen black, pruinose. Male hypopygium (Plate 2, fig. 31) with the tergite, *9t*, extensive, the caudal margin profoundly bilobed by a narrow U-shaped notch; lateral margins of lobes before apex with an obtuse lateral shoulder. Outer lobe of basi-

style, *b,* relatively slender, with long setæ. Dististyle, *d,* very broadly flattened, extended into a moderately slender beak. Interbase, *i,* deeply bifid before apex, the outer lobe slender, the inner more obtuse, with a lateral flange back from its apex, the margin of lobes microscopically serrulate.

Habitat.—China (Szechwan).

Holotype, male, Wen Chuan, November 15 to December 5, 1934 (*Graham*).

Dicranota (*Rhaphidolabis*) *biloba* has no close ally among the described regional species of the subgenus. In its general appearance it is most like *D.* (*R.*) *flavibasis* (Alexander), of Japan, which has the wing pattern and venation somewhat similar, but with the details of structure of the male hypopygium entirely different. The profoundly bifid ninth tergite is quite distinct from the condition found in all other species of *Dicranota* known to me.

ULA PROVECTA sp. nov. Plate 1, fig. 15.

General coloration brownish black to black; antennæ elongate; halteres black, the bases restrictedly pale; wings with a strong blackish tinge, the stigma entire, slightly deeper in color; a darkened cloud on r-m; abdomen black.

Female.—Length, about 6 millimeters; wing, 7.4.

Rostrum and palpi black. Antennæ black throughout, relatively elongate for the female sex in this genus; flagellar segments cylindrical; longest verticils subequal to or just exceeding the segments in length; terminal segment a little longer than the penultimate. Head brownish black.

Mesothorax almost uniformly brownish black, without clearly defined markings or pruinosity. Halteres black, the base of stem narrowly paler. Legs with the coxæ and trochanters dark brown; remainder of legs brownish black to black. Wings (Plate 1, fig. 15) with a strong blackish tinge, the stigma and a cloud on r-m deeper in color; stigma uniformly darkened; scarcely evident paler areas at Sc_2, origin of Rs, and outer end of cell 1st M_2; veins brownish black. Macrotrichia lacking in proximal ends of all basal cells (presence of trichia indicated by stipplings in figure). Venation: Rs long, angulated at origin; r-m connecting with Rs immediately before fork; cell 1st M_2 relatively small, shorter than vein M_4 beyond it; m-cu near proximal end of cell 1st M_2, in approximate transverse alignment with r-m.

Abdomen black; valves of ovipositor horn yellow.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*).

Ula provecta is very distinct from the only other species of the genus so far made known from western China, *Ula comes* Alexander, in the nearly unpatterned wings. It is most generally similar to *Ula fuscistigma* Alexander (Formosa) in its general appearance, differing in the unusually dark ground color of the wings, the position of Sc_2 at about two-thirds the distance between arculus and origin of Rs, and the considerably larger cell 1st M_2.

HEXATOMINI

ADELPHOMYIA MAJUSCULA sp. nov. Plate 1, fig. 16.

Size large (wing, female, 8 millimeters); general coloration of thorax and abdomen black, the præscutum subnitidous; legs yellow, the femoral tips narrowly blackened, the outer tarsal segments black; wings strongly tinged with brown, the stigma darker; trichia of wing cells unusually abundant, occurring in cells Sc_2 to Cu, inclusive; vein R_2 obsolete or virtually so; veins R_3 and R_4 rather strongly divergent; cell M_1 small.

Female.—Length, about 9 millimeters; wing, 8.

Rostrum and palpi black. Antennæ black, the flagellar segments beyond the basal two or three becoming very slender to setaceous, with very long, conspicuous setæ. Head dark brownish gray, somewhat clearer gray on front.

Pronotum black, sparsely pruinose. Mesonotal præscutum black, subnitidous, the posterior sclerites of notum more heavily pruinose. Pleura black, sparsely pruinose. Halteres pale yellow throughout. Legs with the coxæ brownish black, the fore coxæ more intensely darkened; trochanters obscure yellow; femora yellow, the tips narrowly but conspicuously blackened; tibiæ and tarsi brownish yellow, the outer segments of the latter blackened. Wings (Plate 1, fig. 16) with a strong brownish tinge, the stigma darker brown; veins brown, the prearcular and basal veins somewhat more yellowish. Trichia in outer cells of wing unusually abundant and well distributed, involving the outer portions of cells Sc_2 to Cu, inclusive (indicated in figure by stippled dots). Venation: Sc_1 ending a short distance before fork of Rs, Sc_2 some distance from its tip; R_2 obsolete or nearly so, placed at or just beyond fork of vein R_{3+4}, represented by a weak spur on R_3 close to the fork; vein R_{1+2} strongly sinuous upon entering the stigma; veins R_3 and R_4 rather strongly di-

vergent; cell R_3 at margin wider than cell R_2; cell M_1 small; m-cu just before midlength of cell 1st M_2.

Abdomen black throughout, only the cerci horn brown.

Habitat.—China (Szechwan).

Holotype, female, Beh Luh Din, altitude 4,000 feet, October 10 to 24, 1934 (*Graham*).

Adelphomyia majuscula is readily told from the other described Asiatic species by the large size, in conjunction with the abundant macrotrichia of the outer wing cells, the black coloration of the thorax and abdomen, and the unmarked wings, with vein R_2 obsolete or virtually so.

EPIPHRAGMA (EPIPHRAGMA) SUBOBSOLETA sp. nov. Plate 1, fig. 17.

General coloration of præscutum dark brown, the usual stripes confluent, buffy in front, before the suture passing into brown; knobs of halteres with outer portion whitish; legs yellow, the femora with a very narrow, subobsolete brown ring shortly before tip; wings whitish hyaline, with the usual brown pattern of the subgenus, the areas not bordered by darker; outer radial field with pattern paler, more buffy yellow; m-cu at near one-third the length of cell 1st M_2; abdominal tergites dark brown, the sternites obscure yellow.

Female.—Length, 11 to 12 millimeters; wing, 9.5 to 10.

Rostrum and palpi black. Antennæ with scape and pedicel black; basal flagellar segment yellow, the succeeding segments black; flagellar segments cylindrical, with long conspicuous verticils that exceed the segments in length. Head above rich brown, a little brightened on orbits.

Pronotum dark brown. Mesonotal præscutum with the ground color dark brown, the usual stripes confluent, buffy in front, before the suture resolving into four more brownish areas, the intermediate pair separated by a pale line; posterior sclerites of mesonotum chiefly darkened, more or less pruinose. Pleura black, variegated by slightly more pruinose areas. Halteres dusky, the distal half of knob paling to whitish. Legs with the coxæ brownish black; trochanters obscure yellow; femora yellow with a very narrow and indistinct, pale brown ring some distance before apex, in the holotype this ring very faintly to scarcely indicated; remainder of legs yellow, the terminal tarsal segments a trifle darker. Wings (Plate 1, fig. 17) whitish hyaline, with the usual brown pattern, the areas in outer

radial field conspicuously paler, more buffy yellow; small darker brown dots at ends of veins R_{1+2}, R_3, and R_4; dark areas not bordered by deeper colors, as in several allied forms; cord and outer end of cell 1st M_2 narrowly seamed with brown; veins brown, somewhat paler in the hyaline areas. Venation: Supernumerary crossvein in cell C transverse in position; basal section of R_5 reduced (as shown) or of normal length; m-cu at near one-third the length of cells 1st M_2.

Abdominal tergites chiefly dark brown; sternites obscure yellow. Valves of ovipositor deep cherry red.

Habitat.—China (Szechwan).

Holotype, female, Mount Omei, altitude 5,500 to 11,000 feet, August 16 to 20, 1934 (*Graham*). Paratopotype, female.

The only other species of the genus known from western China is *Epiphragma* (*Epiphragma*) *bicinctifera* Alexander, readily told by the two darkened femoral rings. In the combination of body coloration and leg and wing pattern, the present insect similarly differs from all other species hitherto described from eastern Asia.

LIMNOPHILA (ELÆOPHILA) LILLIPUTINA sp. nov. Plate 1, fig. 18; Plate 2, fig. 32.

Size very small (wing, male, less than 4 millimeters); antennal flagellum pale; femora with a brown apical ring; wings broad, whitish subhyaline, heavily patterned with brown, including a series of about six major costal areas; dark dots in interspaces restricted in number, lacking in cephalic portion; male hypopygium with the flange of the outer dististyle subacute; apical spine of style smooth, the margin basad of this point microscopically roughened.

Male.—Length, about 3.5 millimeters; wing, 3.8.

Described from an alcoholic specimen.

Rostrum and palpi dark brown. Antennæ with scape and pedicel dark flagellum yellow, the outer segments a trifle darker; flagellar segments oval. Head dark brown.

Mesonotum chiefly dark brown, in fresh specimens presumably pruinose and more or less patterned. Pleura brown. Halteres pale, the knobs dark brown. Legs with the coxæ and trochanters dark brown; femora yellow, the tips rather broadly and abruptly dark brown, not blackened as in *dietziana;* remainder of legs yellow, the tips of the tibiæ very narrowly darker. Wings (Plate 1, fig. 18) whitish subhyaline, heavily patterned with brown, including a series of about six larger costal areas that are subequal to or narrower than the pale interspaces; dark dots in the

pale discal areas restricted in number, lacking in the costal and subcostal fields; band at origin of Rs and along the supernumerary crossvein narrow but complete. Venation as in *dietziana.*

Abdomen dark brown, the incisures somewhat paler. Male hypopygium with the outer dististyle (Plate 2, fig. 32, *od*) having the outer lobe or flange subacute, not rounded at apex as in *dietziana;* apical spine of style slender, smooth, the margin basad of the apex with microscopic spinulæ.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Kibune, Kyoto, August 17, 1932 (*Tokunaga*).

The nearest regional ally of the present fly is *Limnophila* (*Elæophila*) *dietziana* Alexander, which differs especially in the larger size, black femoral apices, more heavily dotted wing pattern, and the details of the male hypopygium, notably the obtuse flange of the outer dististyle, the more strongly curved apical spine, and the entirely smooth margin basad of this point.

LIMNOPHILA (PRIONOLABIS) PILOSULA sp. nov. Plate 1, fig. 19; Plate 2, fig. 33.

General coloration black, sparsely pruinose; antennæ 16-segmented, black throughout; halteres unusually elongate, whitish, the knobs weakly darkened; legs brownish black to black; wings broad, whitish subhyaline, the stigma and a restricted cloud on anterior cord pale brown; numerous coarse macrotrichia in cells of wing beyond cord; cell M_1 present; m-cu lying far distad, at or beyond three-fourths the length of cell 1st M_2; male hypopygium with the outer dististyle bearing a single, slender, erect spine before the curved, acute, terminal spine; inner dististyle terminating in a simple yellow blade.

Male.—Length, 8 to 10.5 millimeters; wing, 10 to 13.5.

Rostrum and palpi black. Antennæ 16-segmented, black throughout; flagellar segments oval, becoming smaller outwardly, the terminal segment exceeding the penultimate. Head dull black; anterior vertex wide.

Thorax almost uniformly dull black, the surface very sparsely pruinose. Halteres of unusual length, whitish, the knobs weakly darkened. Legs with coxæ and trochanters black; remainder of legs brownish black to black, moderately hairy. Wings (Plate 1, fig. 19) broad, whitish subhyaline, the stigma and a restricted cloud on anterior cord pale brown; veins brown. Conspicuous coarse macrotrichia in cells of wing beyond cord (in figure represented by stippled dots). Venation: Sc_1 ending

shortly before fork of R_{2+3+4}, Sc_2 nearly opposite the fork of Rs; R_2 faint, subequal to R_{1+2}; cell M_1 present; m-cu lying far distad, at near three-fourths to four-fifths the length of cell 1st M_2.

Abdomen, including hypopygium, black, sparsely pruinose. Male hypopygium (Plate 2, fig. 33) with the median region of tergite, *9t*, gently emarginate, the lateral portions of the notch a trifle produced. Outer dististyle, *od*, with the basal half swollen and provided with elongate setæ, the distal portion narrowed to an acute, gently curved spine, with a smaller, more slender denticle back from tip; inner dististyle, *id*, a simple yellow blade. Ædeagus, *a*, and gonapophyses, *g*, both appearing as compressed yellow blades, as shown, the latter wider than in most other species of the subgenus.

Habitat.—China (Szechwan).

Holotype, male, Wen Chuan, November 15 to December 5, 1934 (*Graham*). Paratopotypes, 12 males.

The present fly is amply distinct from the remaining score of species of the subgenus in the pilosity of the outer cells of the wing. In its size and general appearance it is most like such a species as *Limnophila* (*Prionolabis*) *rufipennis* Alexander, of Japan, yet is very distinct. The subgenus had not been recorded previously from China.

ERIOPTERINI

GONOMYIA (GONOMYIA) LUTEIPLEURA sp. nov. Plate 1, fig. 20.

General coloration yellow, the præscutum and scutum conspicuously patterned with dark brown; thoracic pleura immaculate yellow or virtually so; wings strongly tinged with yellow, the stigma vaguely darkened; Sc short, Sc_1 ending exactly opposite origin of Rs; cell 1st M_2 open by atrophy of m; abdominal tergites dark brown medially.

Female.—Length, about 5 millimeters; wing, 5.

Described from an alcoholic specimen.

Rostrum and palpi obscure yellow. Antennæ moderately elongate, pale brown; flagellar segments passing through oval, elongate-oval to linear. Head light brown.

Thorax yellow, the præscutum with three conspicuous dark brown stripes that are subconfluent, the median stripe narrowly split at cephalic end; scutal lobes chiefly darkened, the posterior fourth of each yellow; median area of scutum and the scutellum yellow; mediotergite weakly darkened. Pleura, including pleurotergite, yellow, without clearly defined darkenings. Halteres elongate, pale. Legs with the coxæ and trochanters yellow; re-

mainder of legs brownish yellow, the terminal tarsal segments darker. Wings (Plate 1, fig. 20) strongly tinged with yellow, the stigmal region vaguely darkened; veins brownish yellow. Venation: Sc short, Sc_1 ending exactly opposite origin of Rs, Sc_2 not clearly evident in the type but presumably at the extreme tip of Sc_1; r-m at fork of Rs; R_{2+3+4} elongate, approximately five-sixths Rs; cell 1st M_2 open by the atrophy of m; m-cu shortly beyond fork of M.

Abdomen with the tergites dark brown medially, pale yellow laterally; sternites yellow.

Habitat.—Japan (Honshiu).

Holotype, alcoholic female, Mount Daisen, Hoki, July 2, 1931 (*Tokunaga*).

The nearest described ally is *Gonomyia* (*Gonomyia*) *gilvipennis* Alexander, which differs especially in the pattern of the thorax and in the venation, as the elongate Sc, which ends at or beyond one-third the length of Rs. The open cell 1st M_2 in the present species may be an abnormality of the unique type, but certainly appears to represent a normal condition, being virtually the same on both wings. If the cell is normally closed it would be of unusual length, since vein M_{3+4} is longer than M_4.

TRENTEPOHLIA (MONGOMA) PLATYLEUCA sp. nov. Plate 1, fig. 21.

Allied to *tenera;* head dark brown; mesonotal præscutum almost uniformly dark brown or brownish black; scutellum and mediotergite obscure yellow; pleura chiefly yellow; femora dark brown throughout, tibiæ paling to yellowish white on distal half; tarsi yellowish white; a series of about ten small erect spines at base of femur; wings grayish subhyaline; inner end of cell M_3 lying far proximad of other outer cells.

Female.—Length, about 9.5 millimeters; wing, 7.6.

Rostrum brownish yellow; labial palpi pale; maxillary palpi with outer segment darkened. Antennæ with scape brown; pedicel and flagellum black; flagellar segments long-oval, with scattered setæ of moderate length. Head dark brown; anterior vertex reduced to a linear strip.

Pronotum dark brown above, narrowly yellow laterally. Mesonotal præscutum almost uniformly dark brown or brownish black; median region of scutum obscure yellow, the lobes darkened; scutellum and mediotergite obscure yellow. Pleura with the dorsopleural region, propleura, and anepisternum darkened, the remaining pleura and pleurotergite yellow. Halteres dusky, the base of stem restrictedly pale. Legs with the fore coxæ

darkened, the remaining coxæ and all trochanters yellow; femora dark brown throughout; tibiæ with about the basal half pale brown, the distal portion passing into yellowish white; tarsi yellowish white; a series of about ten small erect spines at base of each femur. Wings (Plate 1, fig. 21) grayish subhyaline, cells C and Sc a trifle darker in color; stigma narrow, darker brown; veins brown. Venation: Rs of moderate length, about a third longer than the basal section of R_5; R_5 a little shorter than the cephalic face of cell 1st M_2 ($R_5 + M_{1+2}$); inner end of cell M_3 lying far proximad of other cells; m-cu very close to fork of M; apical fusion of Cu_1 and 1st A slight; cell 2d A relatively wide.

Abdomen with the tergites brown, the basal sternites light yellow, the outer ones more infuscated. Ovipositor with valves horn-colored.

Habitat.—Formosa.

Holotype, female, Kuraru, August 12, 1934 (*Gressitt*); in author's collection.

Despite the uniformly darkened femora, I regard the present fly as being most nearly allied to *Trentepohlia* (*Mongoma*) *tenera* (Osten Sacken), of the Philippine Islands. By Edwards's arrangement of the Oriental species of *Mongoma*,[4] the fly traces to *pallidiventris* Brunetti, *pallidipes* Edwards, and other forms, differing in the pattern of the body and legs. By my key to the Philippine species of the genus,[5] the fly runs to *T.* (*M.*) *alboterminalis* Alexander, a very different fly. There is no very closely allied species hitherto made known from China, Japan, or Formosa.

ORMOSIA BIANNULATA sp. nov. Plate 1, fig. 22; Plate 2, fig. 34.

Mesonotum brownish gray, the posterior sclerites and pleura brownish black, more or less pruinose; femora black, paler basally, with two narrow yellow rings, the apical one narrower; tibiæ and tarsi black; wings pale brown, conspicuously variegated by whitened areas, including a series in outer ends of the cells before the margin; R_2 a short distance before the fork of R_{3+4}; veins R_3 and R_4 upcurved at outer ends; male hypopygium with the outer dististyle a slender curved spine, the basal portion more dilated; inner style shorter, unequally bidentate at

[4] Journ. Fed. Malay States Mus. 14 (1928) 110–111.
[5] Philip. Journ. Sci. 53 (1934) 442–444.

apex; gonapophysis blackened, flat, the apex bispinous, the upper and lower margins with appressed serrations.

Male.—Length, about 4.5 millimeters; wing, 5.5.

Rostrum and palpi black. Antennæ black throughout, of moderate length, if bent backward extending to beyond the wing root; flagellar segments long-oval, with long, secund setæ on the more basal segments. Head brownish gray.

Mesonotum brownish gray, injured in the type, the præscutum apparently without stripes. Pleura and posterior sclerites of notum brownish black, more or less pruinose. Halteres pale, the base of knob a trifle darker. Legs with the coxæ brownish black; trochanters brownish yellow; femora black, narrowly yellowish at base; a narrow yellow ring at near two-thirds the length, together with the apex narrowly of the same color; tibiæ and tarsi black. Wings (Plate 1, fig. 22) pale brownish, conspicuously variegated by clearer whitened areas, distributed as follows: In cell R, before and beyond origin of Rs; most of cell R_1 and adjoining portion of Sc_1; conspicuous white spots in outer ends of cells R_2, R_3, R_4, R_5, 1st M_2, 2d M_2, M_4, and 1st A; basal portion of cell 1st A similarly whitened; stigmal area slightly darker brown; veins and trichia of the darkened areas of the cells deeper brown. Venation: R_2 a short distance before the fork of R_{3+4} the tips of the latter veins gently upcurved; inner end of cell 1st M_2 truncate; m-cu sinuous, before the fork of M; vein 2d A strongly sinuous.

Abdomen, including the hypopygium, brownish black. Male hypopygium (Plate 2, fig. 34) with the tergite, *9t*, broad. Basistyle, *b*, with the apical margin produced into a flattened glabrous lobe, its apex obtusely rounded. Two dististyles, *d*, one a slender curved spine from a more dilated basal portion, the second shorter, unequally bidentate at apex. Gonapophyses, *g*, appearing as blackened flat blades, terminating in two major acute spines, with additional appressed serrations on both the upper and lower margins of the structure. Ædeagus, *a*, slender.

Habitat.—China (Szechwan).

Holotype, male, Beh Luh Din, altitude 4,000 feet, October 10 to 24, 1934 (*Graham*).

The nearest ally of the present fly is *Ormosia pulchra* (Brunetti), of the western Himalayas, which differs especially in the details of coloration of the body and in the pattern of the wings. The male sex of the latter species is still unknown.

ERIOPTERA (ERIOPTERA) ALBOGUTTATA DAISENICA subsp. nov. Plate 2, fig. 35.

Male.—Length, about 3.5 millimeters; wing, 3.8.

Generally similar to *Erioptera* (*Erioptera*) *alboguttata* Edwards (Formosa), differing especially in hypopygial characters. Wings somewhat broader, with the white spots smaller and more clearly delimited; white band at cord disconnected from the area on Sc; spots in outer radial field much smaller than the interspaces.

Male hypopygium (Plate 2, fig. 35) with the distal portion of the inner dististyle, *id*, more slender than in the typical form, the long pale setæ at the bend of the style exceeding in length the apical spine beyond the point of their insertion. Outer gonapophyses, *og*, short and broad, more or less boomerang-shaped, the setæ restricted to outer half; apical blackened spine short and cultriform.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Mount Daisen, Hoki, July 2, 1931 (*Tokunaga*).

ERIOPTERA (CHEILOTRICHIA) LÆTIPENNIS sp. nov. Plate 1, fig. 23; Plate 2, fig. 36.

General coloration pale yellow to brownish yellow; antennal flagellum yellow; tips of femora narrowly darkened; tibiæ conspicuously ringed with brownish black and yellow, clothed with elongate setæ; wings pale yellow, sparsely variegated by brown dots on the crossveins and deflections, and by a more extensive dusky cloud at wing apex; veins R_{2+3+4} and R_{3+4} subequal in length; male hypopygium with dististyles and gonapophyses entirely pale; outer dististyle a simple sinuous rod.

Male.—Length, about 2.5 millimeters; wing, 2.6.

Female.—Length, about 2.8 millimeters; wing, 2.9 to 3.

Described from alcoholic specimens.

Rostrum and palpi brown. Antennæ with scape and pedicel brown; flagellum yellow.

Mesonotal præscutum almost uniformly yellow, the posterior sclerites slightly darker. Pleura yellow, the sternopleurite a little darker. Halteres pale yellow. Legs with the coxæ and trochanters yellow; legs chiefly detached, conspicuously hairy; a middle leg still in position is colored as follows: Femur yellow, the tips narrowly darkened; tibia brown at both ends, the slightly more extensive central portion yellowish white; basal two tarsal segments whitish, the terminal three segments darker; setæ of tibia longer and darker in color on the infus-

cated portions than on the pale central area. Other detached legs show the femora chiefly darkened, with a narrow pale ring before outer end; a further leg, apparently representing the posterior pair, has the entire basal three-fourths of the tibia yellow, the distal fourth darkened, the vestiture conforming in color to the region where borne, the setæ of the apical fourth long and conspicuous. Wings (Plate 1, fig. 23) pale yellow, sparsely variegated by dark dots on many of the crossveins and deflections, and by a more extensive pale brown wash in outer ends of outer radial and medial fields, involving cells R_4 to 2d M_2, inclusive; dark seams and dots distributed as follows: At arculus, origin of Rs, Sc_2, along all elements of the cord and outer end of cell 1st M_2, R_2, and as smaller marginal dots at ends of all longitudinal veins; veins pale yellow, a little darkened in the clouded areas. Venation: Sc_2 at extreme tip of Sc_1; R_{2+3+4} subequal to R_{3+4}, R_2 being at near midlength of the anterior branch of Rs; veins R_3 and R_4 relatively long and lying generally parallel to one another; cell 1st M_2 closed; m-cu erect, more than one-half its length before the fork of M; anal veins divergent.

Abdomen pale brownish yellow. Male hypopygium (Plate 2, fig. 36) with apex of basistyle produced into a pale lobe. Both dististyles entirely pale, the outer, *od*, a long, sinuous, simple, acicular rod that gradually narrows to an acute point. Inner dististyle, *id*, bifid, entirely pale. Gonapophyses, *g*, entirely pale, appearing as two, slender, submedian rods, lying generally parallel to one another, and with smaller, lateral, spiniform blades.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Kibune, Kyoto, August 17, 1932 (*Tokunaga*). Allotopotype, female. Paratopotype, female.

Erioptera (*Cheilotrichia*) *lætipennis* is very different from the only other member of the subgenus in eastern Asia, *E.* (*C.*) *imbuta* Wiedemann, in the variegated wings, patterned tibiæ, and very different structure of the male hypopygium. The latter species likewise occurs in Japan and its hypopygium is shown for comparison (Plate 2, fig. 37). Note especially the entirely pale, expanded outer dististyle, *od*, with a stout marginal spine on basal half; bifid inner dististyle, *id*, with the outer arm blackened and bidentate at apex; conspicuously blackened gonapophyses, *g*, the outer pair spinose on distal half, the inner pair with weaker spinulæ before the apex.

Whether the groups *Cheilotrichia* Rossi (1848) and *Empeda* Osten Sacken (1869) can be maintained as distinct is becoming very questionable in my mind. Almost the only character still available for defining the two groups is found in the extreme distal position of vein Sc_2, which lies at or very close to the extreme tip of Sc_1 in *Cheilotrichia.* In *Empeda* this element is slightly removed from the tip of Sc_1 while yet lying far more distad than in the remaining subgeneric divisions of *Erioptera.*

MOLOPHILUS POLYCANTHUS sp. nov. Plate 1, fig. 24; Plate 2, fig. 38.

Belongs to the *gracilis* group and subgroup; general coloration brown; antennæ short in both sexes; male hypopygium with two slender pale spines on either side, additional to the blackened dististyles, the inner one of the latter with the distal third set with abundant microscopic spines.

Male.—Length, about 3.5 millimeters; wing, 3.5.

Female.—Length, about 4.5 millimeters; wing, 4.

Described from alcoholic specimens.

Rostrum and palpi brown. Antennæ short, if bent backward ending about opposite the wing root, pale brown throughout. Head brown.

Thorax almost uniformly brown, without evident markings (in spirit). Halteres white. Legs with the coxæ and trochanters brownish yellow; femora obscure yellow, the tips weakly darkened; remainder of legs yellow, the terminal tarsal segments darker. Wings (Plate 1, fig. 24) tinged with yellow or brownish yellow; veins pale brown. Venation: R_2 lying slightly distad of r-m; vein 2d A nearly straight, ending about opposite m-cu.

Abdomen brown, the hypopygium a trifle paler, yellowish brown. Male hypopygium (Plate 2, fig. 38) with the inner dististyle, *id,* the longest element, its distal third armed with numerous small suberect spines. Outer dististyle, *od,* a smooth, sinuous blackened horn. Ventral lobe of basistyle, *vb,* long and conspicuous. Two very long, slender, pale spines apparently arise from the distal end of the basistyle, one close to the base of the ventral lobe, the other much more distad, possibly arising from the dorsal lobe of the style, but this not clear in the slide mount. Phallosomic plate oval in outline.

Habitat.—Japan (Honshiu).

Holotype, alcoholic male, Kibune, Kyoto, August 17, 1932 (*Tokunaga*). Allotopotype, female. Paratopotypes, 1 male, 1 female.

Molophilus polycanthus is very distinct from other regional species of the genus in the structure of the male hypopygium. The forms that are most similar are *M. ferox* Alexander, *M. takaoensis* Alexander, and *M. triacanthus* Alexander, all differing notably in the details of hypopygial structure.

ILLUSTRATIONS

[*a*, Ædeagus; *b*, basistyle; *d*, dististyle; *dd*, dorsal dististyle; *g*, gonapophysis; *i*, interbase; *id*, inner dististyle; *ig*, inner gonapophysis; *od*, outer dististyle; *og*, outer gonapophysis; *s*, sternite; *t*, tergite; *vb*, ventral lobe of basistyle; *vd*, ventral dististyle.]

PLATE 1

FIG. 1. *Tanyptera cognata* sp. nov., venation.
2. *Pselliophora stabilis* sp. nov., venation.
3. *Pselliophora lauta* sp. nov., venation.
4. *Dictenidia luteicostalis* sp. nov., venation.
5. *Tipula* (*Oreomyza*) *cladomera* sp. nov., venation.
6. *Limonia* (*Limonia*) *arthritica* sp. nov., venation.
7. *Limonia* (*Dicranomyia*) *penita* sp. nov., venation.
8. *Limonia* (*Rhipidia*) *isospilota* sp. nov., venation.
9. *Limonia* (*Rhipidia*) *hypomelania* sp. nov., venation.
10. *Antocha* (*Antocha*) *spicata* sp. nov., venation.
11. *Orimarga* (*Orimarga*) *distalis* sp. nov., venation.
12. *Trichoneura* (*Xipholimnobia*) *javanensis* sp. nov., venation.
13. *Dicranota* (*Rhaphidolabis*) *tuberculata* sp. nov., venation.
14. *Dicranota* (*Rhaphidolabis*) *biloba* sp. nov., venation.
15. *Ula provecta* sp. nov., venation.
16. *Adelphomyia majuscula* sp. nov., venation.
17. *Epiphragma* (*Epiphragma*) *subobsoleta* sp. nov., venation.
18. *Limnophila* (*Elæophila*) *lilliputina* sp. nov., venation.
19. *Limnophila* (*Prionolabis*) *pilosula* sp. nov., venation.
20. *Gonomyia* (*Gonomyia*) *luteipleura* sp. nov., venation.
21. *Trentepohlia* (*Mongoma*) *platyleuca* sp. nov., venation.
22. *Ormosia biannulata* sp. nov., venation.
23. *Erioptera* (*Cheilotrichia*) *lætipennis* sp. nov., venation.
24. *Molophilus polycanthus* sp. nov., venation.

PLATE 2

FIG. 25. *Tipula* (*Oreomyza*) *cladomera* sp. nov., male hypopygium, lateral aspect.
26. *Tipula* (*Oreomyza*) *cladomera* sp. nov., male hypopygium, details.
27. *Limonia* (*Dicranomyia*) *penita* sp. nov., male hypopygium.
28. *Limonia* (*Rhipidia*) *hypomelania* sp. nov., male hypopygium.
29. *Antocha* (*Antocha*) *spicata* sp. nov., male hypopygium.
30. *Orimarga* (*Orimarga*) *distalis* sp. nov., male hypopygium.
31. *Dicranota* (*Rhaphidolabis*) *biloba* sp. nov., male hypopygium.
32. *Limnophila* (*Elæophila*) *lilliputina* sp. nov., male hypopygium, outer dististyle.
33. *Limnophila* (*Prionolabis*) *pilosula* sp. nov., male hypopygium.
34. *Ormosia biannulata* sp. nov., male hypopygium.
35. *Erioptera* (*Erioptera*) *alboguttata daisenica* subsp. nov., male hypopygium.
36. *Erioptera* (*Cheilotrichia*) *lætipennis* sp. nov., male hypopygium.
37. *Erioptera* (*Cheilotrichia*) *imbuta* Wiedemann, male hypopygium.
38. *Molophilus polycanthus* sp. nov., male hypopygium.

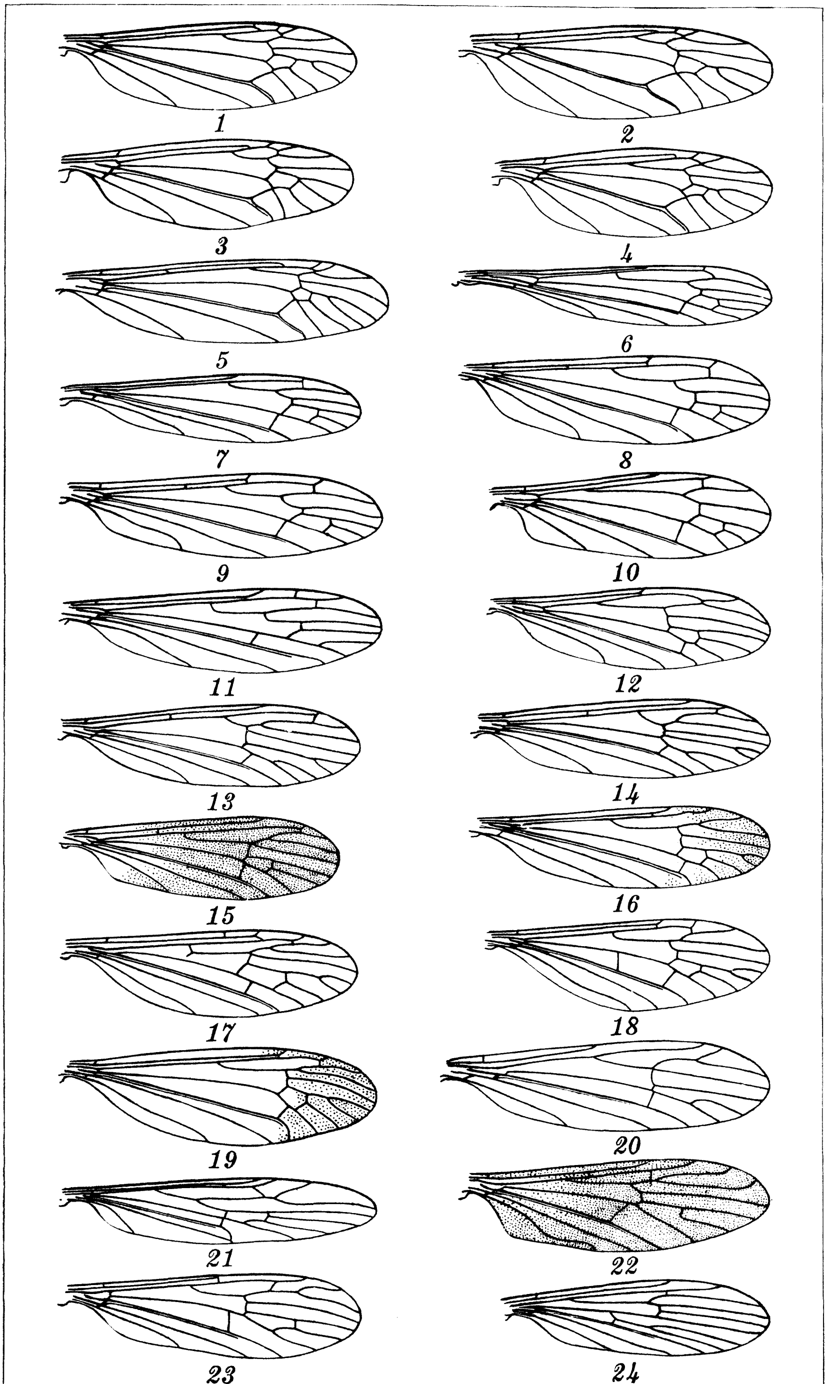

PLATE 1.

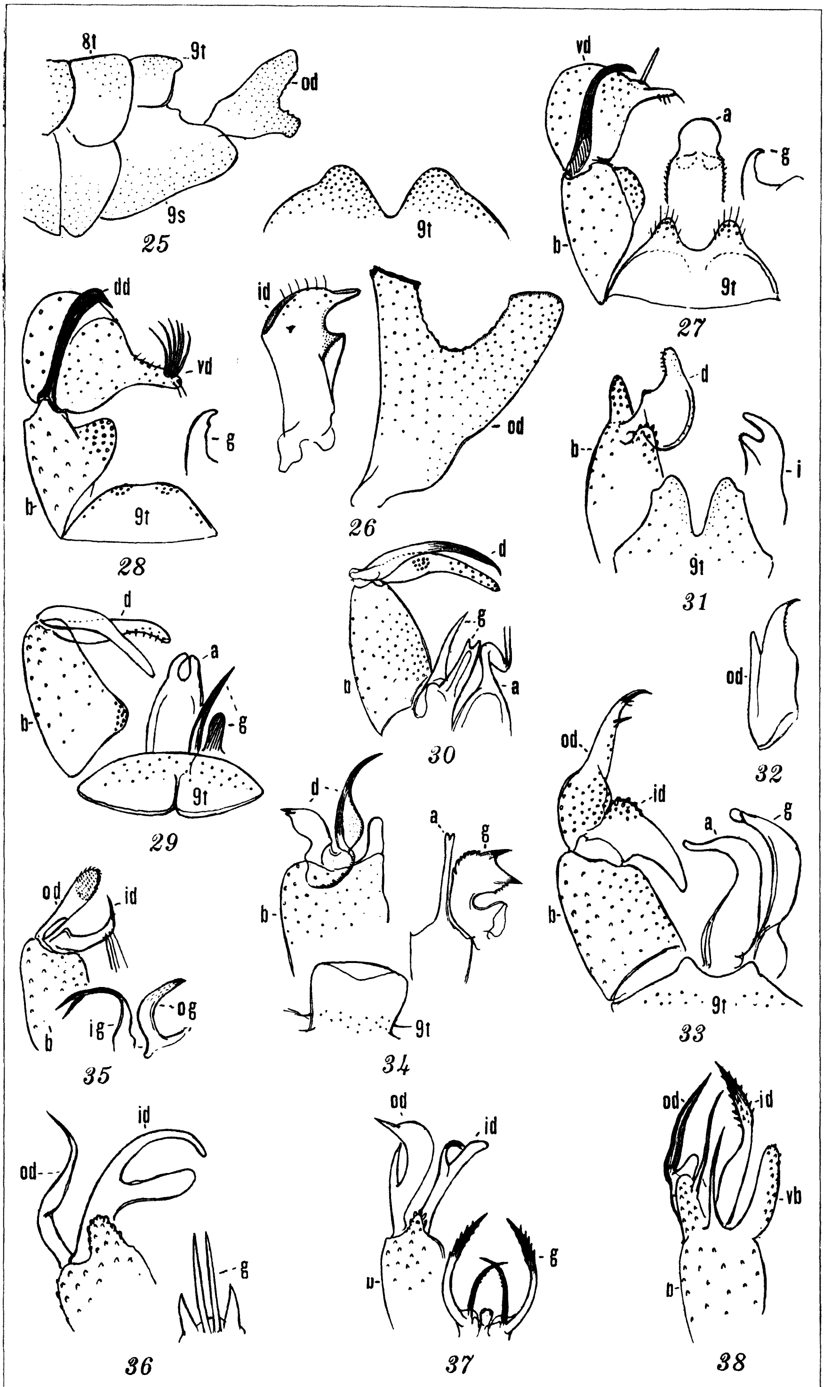
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PLATE 2.

THE MULLET FISHERY OF NAUJAN, MINDORO

ITS EFFECT ON THE SEX RATIO OF THE SPAWNING MULLET MUGIL DUSSUMIERI CUVIER AND VALENCIENNES

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THREE TEXT FIGURES

In a survey of the fisheries of Naujan Lake, Mindoro Island, Herre (1927) found that the ecological conditions obtaining in the lake are exceedingly favorable to the rapid growth and development of mullets. It is, therefore, quite natural to find that nearly all people inhabiting the northern portion of Mindoro as well as those of Batangas and Cavite Provinces and Manila, Luzon, depend on this lake and its outlet, Butas River, for their mullet supply.

Naujan Lake (fig. 1) is a medium-sized, shallow lake situated in the northeastern part of Mindoro. It is approximately 14 kilometers long and 8 kilometers wide, its longer dimension extending in a north-and-south direction. It is mostly 3 to 4 meters in depth, although at places a depth of from 10 to 12 meters is reached. It receives its water supply from numerous small streams and creeks originating in the surrounding plains and hills, mostly from the western and southern sides. Its only outlet is Butas River, which runs a coarse of approximately 6.5 kilometers in a north-northwest direction. At its end it is met by Pinagsabañgan River, the two forming Lumangbayan River, which runs in a northeast direction and empties into the sea. The village of Lumangbayan lies on the beach northward from the mouth of the river. The Butas-Lumangbayan River system is one of the largest river systems in northern Mindoro and forms the dividing line between the lowland on the western side and the mountainous district on the eastern side.

Since 1908 the municipal council of Naujan, Mindoro Province, has awarded, for the purpose of raising revenue, the exclusive rights to exploit the fish resources of the lake and the Butas-Lumangbayan River system to the highest bidder. For the proper conservation of the mullet fishery, ordinances have

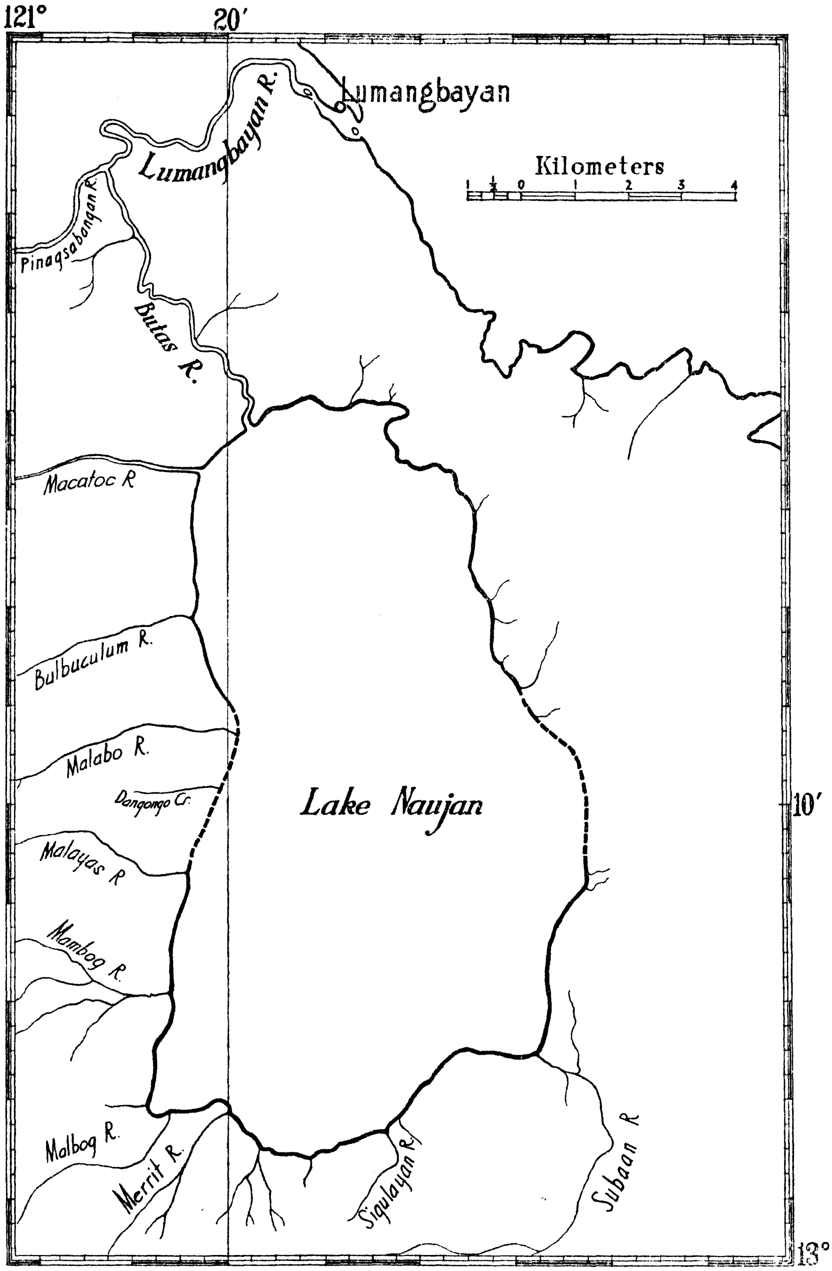

FIG. 1. Naujan Lake, Mindoro.

been passed, establishing a closed season for the catching of mullets. In the beginning the closed season was from October 1 to December 31, inclusive, of each year, but later it was changed to a 30-day period from January 15 to February 15, inclusive. October 15, 1934, the closed season was again changed to the entire month of January of each year. The terms of the award require the lease holder to keep the fish corral situated at Butas River open during the closed season so as to allow the mullets to reach the sea in their seaward migration. During the closed season it is also prohibited to catch mullets in any portion of Lake Naujan, in Butas and Lumangbayan Rivers, and in the municipal waters along the sea adjacent to the mouth of Butas River. Notwithstanding the above-mentioned regulations, which have been in force for over twenty-six years, the inhabitants of Naujan and adjacent places claim that there has been a notable decrease in the mullet catch from year to year. Although this claim cannot be supported by statistical data due to lack of catch records of the various gear used in the region during the past years, the claim that there is a decline in the returns of fishery enterprises in this locality may be taken as an indication that the stability of the fishery is being threatened. Therefore, the condition of the fisheries deserves immediate consideration.

In order to solve the problem of the mullet-fishery conservation, the biology of the mullet, particularly the factors that affect its life history in its up-and-down-stream migration, and the effectiveness of the fishing devices used for catching it were studied. These studies should be continued and the results critically analyzed if satisfactory regulations to prevent the gradual depletion or total destruction of this important fishery are to be promulgated.

Despite the fact that mullets are valuable food fishes, widely distributed in both tropical and temperate waters, nothing is known about the sex ratio of the species under consideration. Investigations and surveys were made by Garrow (1874), Hoxie (1884), Earl (1889), Kishinouye (1898), and Goode (1892), but they were confined to the various experiences of the fishermen and to accounts of fish-culture methods in other countries. Stearns (1879), Dannevig (1902), Roule (1915), Roughley (1916), and Higgins (1924) worked on the habits, migration, racial localization, rate of growth, and size at sexual maturity.

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The typical sex ratio of one to one in sexually reproducing organisms seems to be inapplicable to teleostean fishes. Even if we disregard the result of differential migration or death rate during any stage of development, the fact remains that the male is usually smaller and more agile than the female (Geiser, 1924) and, therefore, has a greater chance to escape. Working on several fishes belonging to the family Pœcilidæ and basing their conclusions on either cytological studies of embryos or examination of adults collected in the field, Hildebrand (1917), Smith (1912), Eigenmann (1904, 1912), Henn (1916), and others found that females greatly predominate over males. Eigenmann (1896), working on *Cymatogaster,* and Hubbs (1921), working on *Amphigonoptera,* found that the ratio is almost one to one. In spawning California barracudas (*Sphyræna argentea*), Wilford (1931) found that there is a very slight preponderance of the males. In true smelts Kendal (1926) found the males predominating, while in jack smelts (Clark, 1929), California sardines (Clark, 1925), and the European plaice (Hefford, 1909) the females were more abundant than the males.

This paper sets forth the effect of the Butas *baclad* on the sex ratio of spawning mullets (*Mugil dussumieri* Cuvier and Valenciennes). This species forms the bulk of the catch of this fish corral as well as of other gear in extensive use during the period of investigation, which covered four months, from November, 1934, to March, 1935. This period practically coincides with the entire mullet season, the peak of which is from November to December. The investigation was undertaken to find out if the fish corral situated about 5 kilometers from the lake from where the fish are migrating and where enormous numbers of mullets are being caught, disturbs the sex ratio of the spawners in their breeding ground in the sea. The investigation also shows how much chance either sex has of reaching the sea to spawn as well as the effect of the late closed season that has been observed for the last twenty-six years.

THE BUTAS BACLAD

The Butas baclad is located in Butas River just above its junction with Pinagsabañgan River. It existed as early as 1908. The period of its lease ranged from four to five years. Under this arrangement, the lease holder has the sole right to catch fish in the lake and Butas River, permitting no other parties to

take advantage of the aquatic resources of these municipal waters. Table 3 shows the amounts for which the Naujan fisheries have been leased since 1908.

The fish corral (fig. 2) has always been of the *bunuhan* type, consisting of two diagonally placed wings (*a*) converging towards the middle of the stream and inclosing a V-shaped area,

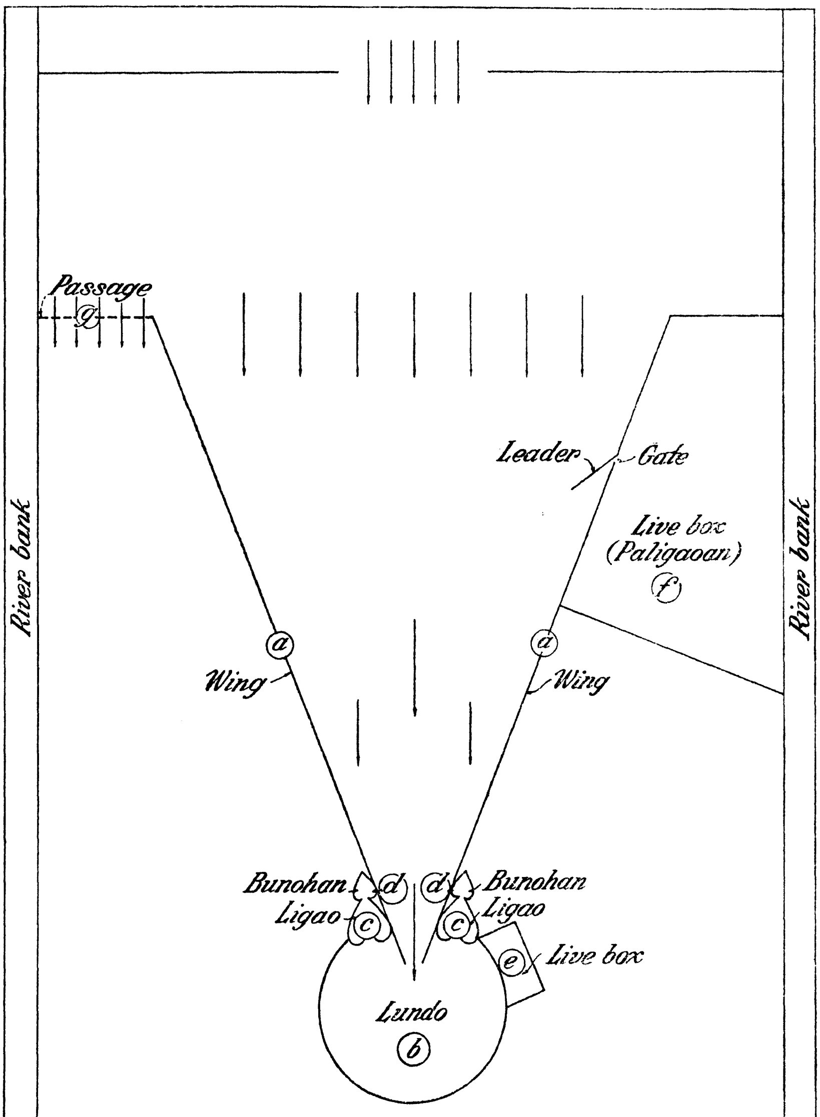

FIG. 2. The Butas baclad in Butas River, Mindoro.

a semicircular inclosure, the *lundo* (*b*), with first and second pairs of heart-shaped inclosures called *ligao* (*c*) and bunuhan (*d*) on each end; and one or two live boxes (*e* and *f*) on one side. The wings cover about three-fourths of the width of the river, leaving a passage (*g*) on one side of the river for bancas to go through. This passage is barred, however, by a dam of bamboo stakes and poles which does not reach the surface of the water. Palm leaves laid across the clear surface serve to frighten the fish away from this open space so that few, if any, attempt to pass here. Ten meters above the corral a fence made of bamboo screen with an opening at the middle is located. This opening as well as the passage (*g*) is first temporarily blocked by bamboo screens or nets before the river is seined to drive the fish into the corral. The fishes are caught at the bunuhan (*d*).

SAMPLING

Samples were collected at very irregular intervals, depending upon the availability of materials, during any one haul of the dip net in the Butas baclad (fish corral) and of the *pukot* (drag seine) at Lumangbayan. During stormy weather, when the pukot could not be used at the latter place, the catch of the *cayod* or *tigpao* (dip net) and *dala* (cast net) were used. Throughout the period of investigation no immature mullets were caught by the above-mentioned gear.

The determination of sex was based on the following sexual dimorphism: Because of much enlarged ovaries, the belly of the female is more angular and much broader than that of the male. In the female a more or less well-developed oviducal aperture, which serves as a passage for the eggs to the outside, is present behind the vent. The urethral aperture is not distinct in the male. Upon pressure, droplets of creamy milt are extruded from the belly of the male, and eggs from the belly of the female. The female is larger than the male. A sexually mature female *banak* has a standard length of from 24 to 36 centimeters; the male, from 19 to 27 centimeters. In water the female is sluggish while the male is active and fast.

RESULTS

Table 1 shows the proportion of males to females as counted from various hauls of the dip net in Butas baclad from November 19 to 27, 1934, from January 23 to 30, from February 1 to 26, and from March 4 to 23, 1935. It can be seen that during

TABLE 1.—*The proportion of male to female mullets at Butas baclad.*

Date.	Total.	Males.	Females.	Ratio of males to females.
1934		*Per cent.*	*Per cent.*	
November 19	60	7	93	1:14
November 23	32	6	94	1:15
November 24	41	2	98	1:40
November 25	63	5	95	1:20
November 27	45	11	89	1:8
Total	241	6	94	1:15
1935				
January 23	26	35	65	1:2
January 24	30	34	66	1:2
January 25	28	21	79	1:4
January 26	34	12	88	1:8
January 27	44	5	95	1:21
January 28	26	3	97	1:25
January 30	50	10	90	1:9
Total	238	16	84	1:7
February 1	50	20	80	1:4
February 3	68	12	88	2:15
February 7	32	6	94	1:15
February 10	11	1	99	1:10
February 14	24	17	83	1:5
February 18	41	15	85	1:6
February 26	31	10	90	1:9
Total	267	17	83	1:7
March 4	60	34	66	1:2
March 6	40	37	63	3:5
March 7	30	34	66	1:2
March 10	35	29	71	2:5
March 15	60	42	58	5:6
March 18	38	47	53	9:10
March 22	60	50	50	1:1
March 23	16	50	50	1:1
Total	339	40	60	1:1.4

all this period there is a great preponderance of females over males in the mullets caught in the fish corral. November 19, 1934, for example, of the 60 mullets caught, only 7 per cent were males, while 93 per cent were females, a ratio of 1 to 14. An equally great preponderance of females over males was observed November 23, 24, and 25, 1934; January 27 and 28, 1935; and February 7, 10, and 26, 1935. In general during the early part of the mullet season the preponderance of females over males was great, and gradually diminished towards the end of the season, when a ratio of almost 1 to 1 was reached.

In November, 1934, for example, of the 241 mullets examined, 94 per cent were females and only 6 per cent males, whereas in March, 1935, of 339 fish examined 60 per cent were females and 40 per cent males. During the last two days of observation, that is March 22 and 23, a ratio of 1 to 1 was observed in 16 mullets examined.

Covering the same period, but on different dates, sex counts were also made on spawning mullets in the sea from hauls of drag seines, dip nets, and cast nets in the neighborhood of Lumangbayan. The result of this count is shown in Table 2. No-

TABLE 2.—*The proportion of male to female mullets at San Jose No. 2 (Lumangbayan).*

Date.	Total.	Males.	Females.	Ratio of males to females.
1934		*Per cent*	*Per cent.*	
November 16	63	95	5	20:1
November 17	55	96	4	26:1
November 21	32	91	9	15:1
November 22	4	100	0	4:0
November 25	18	94	6	17:1
November 26	3	100	0	3:0
November 27	2	100	0	2:0
Total	177	95	5	17:1
December 4	60	10	90	1:9
December 6	52	4	96	1:25
December 7	63	2	98	1:20
December 8	60	3	97	1:29
December 9	42	5	95	1:20
December 10	37	13	87	1:6
December 12	41	2	98	1:40
December 14	52	4	96	1:25
December 18	47	2	98	1:46
Total	454	5	95	1:18
1935				
January 22	30	34	66	1:2
January 23	50	40	60	2:3
January 24	40	75	25	3:1
January 29	75	60	40	3:2
Total	195	54	46	7:6
February 12	24	83	17	5:1
February 13	57	88	12	7:1
February 17	4	100	0	4:0
Total	85	87	13	7:1
March 5	12	100	0	12:0
March 12	0	0	0	0
March 19	0	0	0	0

vember 16, 1934, of the 63 mullets examined, 95 per cent were males, and only 5 per cent were females. During the latter half of November, 1934, there was a great preponderance of males over females. In January, February, and March, 1935, there was also a preponderance of males over females when of 292 mullets examined there was a ratio of almost 4 to 1.

TABLE 3.—*Lease of the Naujan fisheries.*

Period of lease.	Years.	Amount.	Yearly rate.
		Pesos.	*Pesos.*
1908-1911	4	1,236.00	309.00
1912-1916	5	7,500.00	1,500.00
1917-1920	4	10,000.00	2,500.00
1921-1924	4	14,000.00	3,600.00
1925-1929	5	26,250.00	5,250.00
1930-1934	5	40,000.00	8,100.00
1935-1939	5	55,965.00	11,193.00

This condition, however, did not obtain during December when of 454 fishes examined only 5 per cent were males, while 95 per cent were females, or a ratio of 1 to 19. This is explained by the fact that November 28, 1934, a strong typhoon visited the northern part of Mindoro, causing the swelling of the water in Lake Naujan and Butas River. This inundation resulted in the total destruction of the Butas baclad, which was not repaired till about the middle of January, 1935. During December, therefore, when the Butas baclad was out of commission, the mullets from the lake migrated unmolested towards the sea. Fishing activities of Lumangbayan were also suspended for five days because of strong gales and high waves. When fishing was resumed, hundreds of mullets were caught daily by means of drag seines (cayod), and cast nets (dala). It was during this period that the females outnumbered the males at Lumangbayan. For example, December 4, 1934, of the 60 mullets examined only 2 were males, the rest were females, and December 18 the ratio of males to females was 1 to 46.

DISCUSSION

Text fig. 3 shows graphically the relation of the abundance of males and females at different months of the mullet season. Broken lines represent the percentage of males to all fishes, while the solid lines represent the percentage of females to all

fishes. *A* shows the relative abundance of males and females at Lumangbayan, the spawning ground. At this place, except during the period between December 4 and January 18 when the fish corral was out of commission, there is an abundance of males and a scarcity of females. *B* is for Butas baclad, above which is the feeding ground. During the early part of the mullet season at this place there is a high percentage of females and a very low percentage of males. This high percentage of females continues to the middle of February and gradually diminishes towards the end of March. The number of males also continues small to the second week of February and gradually goes up towards March when a ratio of 1 to 1 is reached.

As a result of the presence of the Butas baclad, which catches a large number of sexually mature mullets, the sex ratio of the mullets at their breeding ground is disturbed. In their seaward migration from their feeding ground there is less escape of sexually mature females through the fish corral. They are so heavily laden with eggs and thus sluggish in their movements that they can neither pass through the slats of the fish corral nor jump over the barricade placed across the passage (fig. 2, *g*). The males, on the other hand, have a much greater chance of escaping through the Butas baclad and, therefore, have a much greater chance of reaching the spawning ground.

We presume that during the early and middle part of the mullet season there is a predominance of females over males, although systematic data are lacking. This assumption is based on the incident that during the first half of December, when the mullets were left unmolested as a result of the destruction of the Butas baclad, there was a preponderance of females over males even in the spawning ground. In their breeding ground, however, the males not only predominate over the females but also there is a scarcity of females. This condition is not conducive to proper and adequate formation of larval fishes.

The placing of the closed season for the catching of mullets at such a late period as January or from January 15 to February 16 is defective in the sense that only a very small number of female mullets reach the sea during this period. Thus, the purpose behind the establishment of a closed season is defeated by placing it towards or at the end of the mullet season. Such a late closed season does not permit a sufficient number of egg-

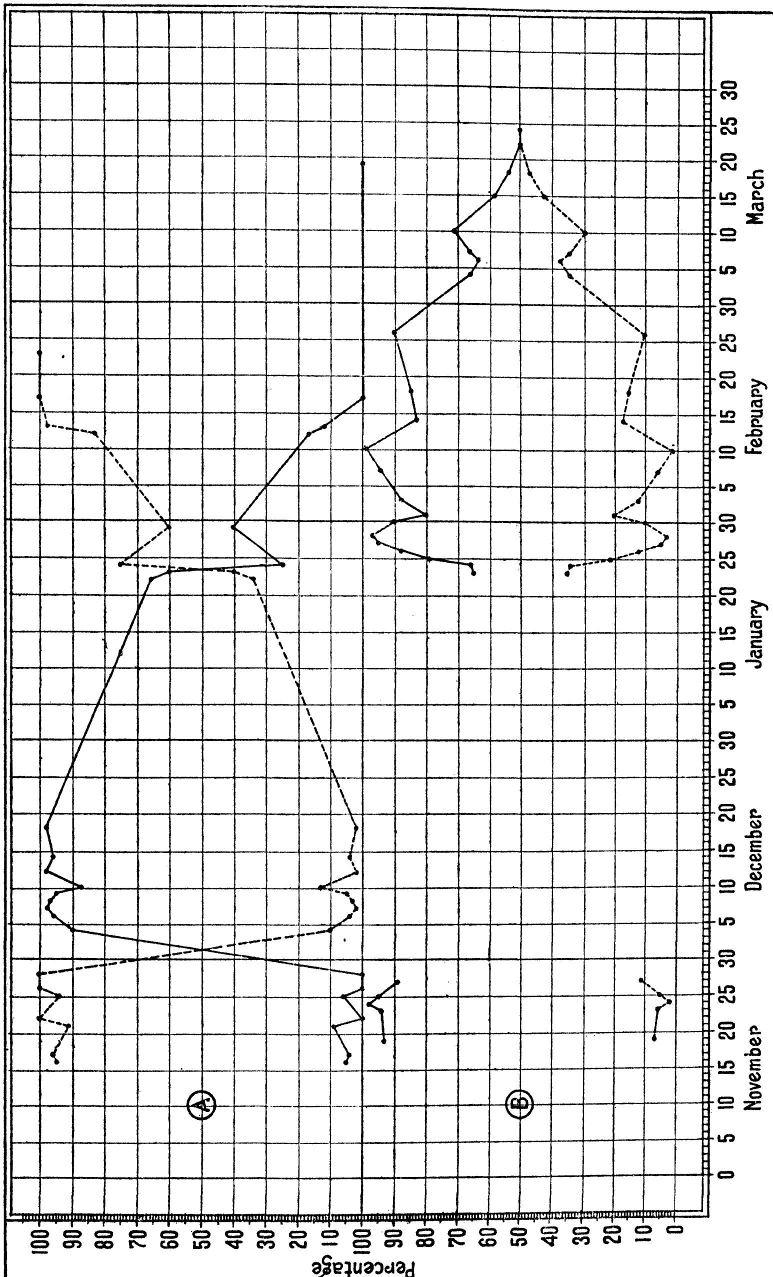

FIG. 3. The relative abundance of male and female mullets in various months of the mullet season. Broken lines represent the percentage of males to all fishes; solid lines represent the percentage of females to all fishes.

laying mullets, which will give rise to fry and fingerlings, to reach the sea.

While it is true that a small portion of Butas River is left open for the passage of bancas during the open season, this passage is nevertheless so treated that it does not allow a normal and sufficient number of egg-laying mullets to escape towards the sea. This condition is best seen during the latter part of November, the latter half of February, and the early part of March, periods of open season, when few or no females are caught on the spawning ground.

Other survey work carried on in Laguna de Bay, Taal Lake, and Naujan Lake showed that the peak of the downward migration of sexually mature mullets is from November 15 to December 15 of each year. This finding was the basis of the provisions of Fish and Game Administrative Order No. 3, which took effect June 16, 1935. This order makes it unlawful during the closed season from November 15 to December 15, inclusive, of each year for any person, association, or corporation to catch or cause to be caught, sell, offer or expose for sale any spawning mullet. Spawning mullets, which may be included with other kinds of fish in a haul or catch, should be immediately set free unhurt. The same administrative order totally prohibits at all times the catching of mullet fry and fingerlings. Besides giving adequate protection to mullets, which carry ripe eggs and milt during their seaward migration, mullet fry and fingerlings should be given every chance to reach their feeding ground, where they attain a marketable size and sexual maturity. The spaces between the slats of fish corrals, partly or totally damming a river, should be made wide enough to allow an unimpeded upward migration of young mullets throughout the year.

SUMMARY AND RECOMMENDATION

1. The mullet season in Naujan Lake and vicinity is from November to March, inclusive, of each year.

2. On the basis of the fishes caught and examined, there appears to be a greater number of females during the early part of this season. Towards the end of the season the preponderance of the females diminishes due to the fact that much fewer females are able to escape.

3. The Butas baclad situated near the outlet of Naujan Lake, Mindoro, caught more sexually mature females than males during the period of investigation.

4. As a result, only few female spawners reach the breeding ground, a fact that, perhaps, partly explains the supposed gradual but continuous decrease in the volume of the mullet catch in Naujan Lake and vicinity from year to year.

5. The placing of the closed season towards the end of the mullet season is defective. Although mullets are left unmolested during this period, only very few sexually mature females reach the sea to spawn.

6. The closed season for mullets should be placed at the early part of the season, if possible, from November 15 to December 16, or better still, from November 1 to December 15 of each year.

7. If this is not possible, the passage (*g*) should be left entirely open and unbarricaded during the entire mullet season and should only be closed temporarily when the river above the fish corral is seined to drive the mullets towards the inclosure.

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ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Naujan Lake, Mindoro.
2. The Butas baclad in Butas River, Mindoro.
3. The relative abundance of male and female mullets in various months of the mullet season. Broken lines represent the percentage of males to all fishes; solid lines represent the percentage of females to all fishes.

FISHES IN THE ZOÖLOGICAL MUSEUM OF STANFORD UNIVERSITY, III

NEW GENERA AND SPECIES OF GOBIES AND BLENNIES AND A NEW MYXUS, FROM THE PELEW ISLANDS AND CELEBES

By ALBERT W. C. T. HERRE
Of Stanford University, California

ONE PLATE

The author spent the month of October, 1933, and part of November, in the Mariana and Caroline Islands, twenty-three days being spent in the Pelew Islands. These islands lie about 750 miles due east of Davao, Mindanao, and are the western outpost of the Caroline Islands. The Pelew group is about 135 miles in length, and about 15 miles in breadth. The rainfall averages 165 inches a year, but there are no fresh-water streams of any consequence, nor could there be in islands of such character. The large island of Bab-el-Thuap has a few permanent streams, but the fresh-water fauna is very limited.

The shore fishes of the Pelew Islands are, in the main, an extension of the fish fauna of the Philippines, Celebes, and the north coast of Dutch New Guinea. They are, therefore, of considerable interest to the student of Philippine fishes, since they throw additional light upon the distribution of fishes in the western Pacific. I have recently published elsewhere a check list of fishes of the Pelew Islands. The present paper describes the new species secured by me and is a continuation of the series on noteworthy fishes in the Stanford University collection.

ELEOTRIDÆ

Genus LIZETTEA novum

The body is thick, robust, wedge-shaped, with a very large, broad, depressed head, projecting lower jaw, and very deep caudal peduncle. There are about 55 ctenoid scales in a longitudinal, 20 in a transverse series, the teeth of the scales very numerous and exceedingly short. There are about 36 cycloid scales before the first dorsal, extending forward to the interor-

bital groove. The snout, lips, underside of the head, and membranous flap of the opercle are naked, the body otherwise is completely scaled; smaller scales cover the bases of the pectoral and caudal fins, the fins otherwise free of scales.

Broad bands, composed of lines of minute foliose papillæ, mark the head elaborately, as follows: One encircling each eye and its adjacent nostrils, the two rings connected by a broad curved band on the interorbital groove; from the lower and posterior sides of this orbital ring 3 more or less branched bands extend across the preopercle; from behind the eye another broad band extends above the preopercle and opercle to a point above the gill opening; from the upper portion of the preopercular margin a band extends downward and curves forward along the underside of the lower jaw to meet its fellow at the symphysis; on the opercle is a narrow vertical stripe posteriorly and 3 transverse lines of papillæ. There are no large pores on the snout or along the margins of the opercle and preopercle.

There are 8 or 10 rows of minute teeth in the upper jaw, those of the innermost row slightly enlarged and depressible; they form a broad band anteriorly, which becomes much narrower posteriorly. In the lower jaw there are 8 rows anteriorly, which dwindle to 3 or 4 rows posteriorly.

First dorsal IV (V ?); second dorsal I, 7; the first dorsal is noticeably low, the dorsals close together; anal I, 7. The second dorsal and anal are short but high. The pectoral, caudal, and ventrals are all pointed.

The anterior nostril is tubulate, the posterior one not. The wide gill openings extend forward beneath the posterior part of the preopercle, the isthmus moderately broad. Branchiostegals 5.

This genus is very close to *Bunaka* Herre, but differs in the dorsal and anal formulæ, the character of the bands of sensory papillæ on the head, the shape of the caudal and pectoral fins, the dentition, and the scalation of the head.

In fresh water. Type of the genus, *Lizettea pelewensis.*

The name is derived from the Christian name of my wife.

LIZETTEA PELEWENSIS sp. nov. Plate 1, fig. 1.

The first dorsal has but 4 spines, but at some distance behind the second spine there is a bony tubercle which probably represents the basal portion of an undeveloped third spine. The second dorsal and anal each I, 7. There are 54 or 55

scales in a longitudinal series, plus about 12 more on the caudal base, and 20 in a transverse series from the origin of the second dorsal to that of the anal; there are about 36 scales before the first dorsal, the snout beyond the middle of the interorbital being naked.

The wedge-shaped body is thick and bulky, with the dorsal outline forming a low arch; the broad head is depressed, the mouth very wide with projecting lower jaw, the cheeks plump.

The width of the head equals the greatest depth of the body, 3.77 times in the length; the head is 2.8 times, the bluntly pointed caudal a shade less than 3 times in the length. The broad interorbital equals the low depressed snout, 4.87 times, the prominent eye 5.5 times in the head; the mouth is oblique, its cleft opposite the lower margin of the eye, the maxillary extending to a point beneath the hind margin of the pupil, and 2.7 times in the head; the top of the snout has a large low hump. The tubulate anterior nostril is very near the margin of the snout; the posterior nostril is above the front margin of the eye; there are no visible pores beside the nostrils or on the margins of the opercle, preopercle, or elsewhere on the head. The least depth of the conspicuously deep caudal peduncle is 2.33 times in the head, 1.45 times in the body depth, and is seven-eighths of its own length.

The dorsals are close together, separated by only two scales; the first dorsal is noticeably low, the second spine highest and 3.9 times in the head or 2.9 times in the depth, the length of the fin base twice in the head; the second dorsal and anal are short but high, the fifth ray in each highest and equal to the depth opposite its base, neither fin reaching the caudal base when depressed; the fifth ray of the second dorsal is 1.8 times in the head, 1.35 times in the depth, the length of the second dorsal base 2.5 times in the head; the fifth anal ray is 1.7 times in the head; 1.26 times in the depth, the length of the anal base 3 times in the head; the large pointed pectoral extends to a line vertical from the anus and equals the depth of the body, 1.34 times in the head; the pointed ventral falls much short of reaching the anus, 1.44 times in the head. The anal papilla is a large, thick, broadly ovate, leaflike organ which extends upon the base of the anal spine.

The color in alcohol is black above and on the sides, each lateral scale with a paler brown margin; underneath the color becomes dusky warm reddish brown, each scale on the breast

and belly with a darker spot, these spots forming rows; the lower portion of the opercle and preopercle and underside of the head are flecked with whitish spots and very short bars; the first dorsal is very dark purplish with black spots; the second dorsal, caudal, and anal are purplish or plum black, the anal with a few pale spots basally; the scaled portion of the pectoral is black, the rest of the fin black with crossbars of pale spots; the ventrals are blackish plum color with whitish crossbars and spots on the basal half.

The type and only specimen, a female 219 mm long, measures 294 mm from the tip of the lower jaw to the tip of the tail. It was taken from a fresh-water brook on a small islet in the Pelew Islands.

GOBIIDÆ

Genus MACRODONTOGOBIUS novum

This genus has the general aspect of *Gnatholepis*, but differs in having two enormous solid incisors side by side on the vomer, extending clear across the roof of the mouth. The entire body except the snout, lips, and underside of the head is covered with large ctenoid scales except before the ventrals, where the scales are cycloid. There are 26 scales in a longitudinal series.

The dorsals are rather low, VI–I, 9; anal I, 9; the rounded caudal and pointed pectoral equal the head; the frenum of the elongate ventral is thin and weak.

The large eyes are very close together and shorter than the prominent snout; the anterior nostril has a very thin-walled tubule, the posterior nostril not tubulate; the small mouth is oblique, with four rows of fine teeth in the upper jaw; the lower jaw has an inner band of four rows of fine teeth and a short outer row of enlarged teeth ending in a small posterior canine laterally. The tip of the tongue is rounded. There are no mucus canals or rows of sensory papillæ on the head.

The gill openings are restricted, scarcely wider than the pectoral base, the isthmus broad; there are no fleshy flaps on the shoulder girdle and no free silky rays on the pectoral.

This genus differs markedly from the other genera thus far known to possess vomerine teeth, *Mars* Jordan and Seale, *Smilogobius* Herre, and *Myersina* Herre, which are all more or less naked anteriorly, and with 50 or more scales in the longitudinal series.

MACRODONTOGOBIUS WILBURI sp. nov. Plate 1, fig. 2.

Dorsal VI–I, 9; anal I, 9; there are 26 scales in a longitudinal, plus 3 more on the caudal base, and 8 in a transverse series; there are 6 predorsal scales, which extend to the eyes, and 3 rows of large scales on the preopercle.

The depth of the elongate, subcylindrical body is 4.7 to 4.8 times, the head 3.6 to 3.7 times in the length; the dorsal profile is greatly convex, the ventral profile nearly horizontal; the head is bluntly rounded, the jaws equal; the protuberant snout is 3.25 times in the head; the large conspicuous eyes are laterodorsal in position, seven-eighths as long as the snout, 3.7 times in the head, and very close together; the interorbital is of negligible breadth, about 9 times in the eye; the mouth is oblique, the maxillary reaching a vertical from the front margin of the pupil, 2.7 times in the head; the very small teeth are in bands of 4 rows each in both jaws; in the lower jaw there is also a short outer row of larger and more widely spaced teeth, ending posteriorly in a small canine on each side; the cheeks are covered with large scales. The depth of the caudal peduncle is 1.8 times in its own length and 2.6 times in the head.

The first dorsal is of moderate height, the tips of the spines more or less threadlike, 1.6 to 1.44 times in the head; the second dorsal is low to medium height, 1.35 to 1.8 times in the head, the anal 1.3 to 1.6 times; both the second dorsal and the anal may almost reach the caudal base when depressed or may fall considerably short of reaching it; the pectoral extends to a vertical from the base of the first ray of the second dorsal and the anal origin, and equals the head; the elongate ventral reaches beyond the anus or the anal fin, and is a little shorter than the head; the narrow round-pointed caudal equals the head; the anal papilla is short, slender, and pointed in males; in females it is short, thick, and nearly cylindrical.

The color in alcohol is whitish gray, much flecked with dusky above and on the sides, and with five large dusky spots along the sides at the level of the pectoral base, the last one on the caudal base; there are traces of four dorsal crossbands; below the eye is a large dark brown or blackish spot extending downward across the cheek; a similar or even larger spot is on the opercle; a diagonal dark brown bar extends downward and forward from the eye across the snout, upper, and lower lips, end-

ing in a spot beneath; the snout and other parts of the head are flecked with dusky spots and short bars; the dorsals, caudal, and pectoral are crossbarred by rows of dark brown or dusky spots; the anal and ventrals are dusky; the eyes are black with iridescent pupils of metallic green, purplish bronze, and red.

Here described from the type, 47 mm long, and 3 paratypes 48, 50, and 42 mm in length, collected on Gorror Reef, Pelew Islands.

I take pleasure in naming this species after Dr. Ray Lyman Wilbur, whose support made it possible for me to visit the Pelews.

VAIMOSA HORIÆ sp. nov.

Dorsal VI–I, 7 or 8; anal I, 6 or 7; there are 24 or 25 scales in a longitudinal series, plus 1, 2, or 3 on the caudal base, and 7 in a transverse series; there are 7 predorsal scales and 5, rarely 6, large opercular scales.

The types are a male 29 mm long and a female 27.5 mm long. The male is big headed with a slenderer body, the female with a smaller head and a much deeper and more robust trunk. Where two measurements are given that of the male is first. The depth is 4.8 to 4.6 times, the head 2.9 to 3.4 times in the length; the rounded caudal equals the head; the pectoral is 4.1 to 4.6 times, the ventral 4.1 to 5, the first dorsal spine 3.6 to 6, the longest second dorsal ray 3.6 to 5.5, the longest anal ray 4.1 to 6.8 times in the length. In the male the last dorsal and anal rays are much the longest, extending upon the caudal when depressed. In the female the third or fourth ray is longest.

The eye is 4 times, the snout 3.6, the interorbital 10 to 8, the least depth of the caudal peduncle 3 to 2.5 times in the head.

The body is thick and robust anteriorly, the dorsal profile nearly horizontal, the ventral profile moderately convex; the broad snout is convex, the mouth oblique, the jaws equal; in the male the maxillary extends beyond the posterior margin of the eye and in the female beneath the posterior part of the pupil. The large ctenoid scales extend forward to the eyes, which are dorsolateral and very close together. On the cheeks, opercles, and nape are rows of sensory papillæ. On the opercle one row describes a complete circle around the central scale. In the females the dorsals and anal are of only moderate height and the second dorsal and anal fall far short of the caudal when depressed.

Paratypes have the depth 4.5 to 5 times, the head 3.1 to 3.6, the caudal 4 to 4.1, the pectoral 4.5 to 5, the ventral 4.4 to 4.6, the first dorsal 4.4 to 4.7, the second dorsal 5.2 to 5.3, the anal 5.5 to 6.5 times in the length; the eye is 3.5 to 3.8 times, the snout 3.5, the least depth of the caudal peduncle 2.4 to 2.65 times in the head.

The snout is usually a little more or less than the eye. The maxillary usually extends to a vertical from the middle of the eye, but in some does not reach so far.

In males the first dorsal spine is more or less elongated, with filiform tip; rarely 3 or 4 spines may have threadlike elongated tips. One male has the first dorsal spine extending beyond the anal, 1.85 times in the total length.

The color in alcohol is more or less brownish or blackish brown above, becoming gray or whitish on the sides and underneath. There are five or six dusky crossbands on the back, two before the first dorsal, one beneath each dorsal fin, and two on the caudal peduncle, which continue down the sides and unite with a row of brown or blackish spots along the middle of the side. In the male type the lateral spots have united to form a longitudinal band. In most specimens the crossbands below the dorsals continue down the sides to the belly, and may unite with the one from the opposite side. There are two black spots on the caudal base, with a clear spot between them. There are two black spots under the anal and two on the underside of the caudal peduncle. Two dusky bars extend from the eye across the mouth to the lower jaw, and other blackish brown bars and spots extend across the cheeks, opercle, and pectoral base. The first dorsal has a conspicuous black basal spot between the fifth and sixth spines, the rest of its base more or less brown, the remainder of the fin clear with a black margin above. The second dorsal is clear with three irregular crossbands of blackish brown; the caudal is clear with five crossrows of blackish spots; the anal and ventrals have blackish rays with clear membrane or may be largely blackish; the pectoral is clear.

Here described from the types and ten paratypes, 21 to 29 mm in length. They were taken from a fresh-water creek on Bab-el-Thuap, the main island of the Pelew Islands, by Mr. Y. Hori, after whom I take pleasure in naming this interesting little fish. Mr. Hori is the scientific expert of the Pelew Fishery Experiment Station.

STIPHODON PELEWENSIS sp. nov.

Dorsal VI–I, 9; anal I, 10; there are 36 scales in a longitudinal series to the upper angle of the pectoral base, and 2 more small scales on the caudal base, 12 predorsal, and 9 in a transverse series.

The depth of the slender body is 7.6 times, the head a trifle over 4 times, and the broadly rounded caudal 3.8 times in the length; the short blunt snout slopes steeply to its tip which projects over the upper lip and is contained 4 times in the head; the interorbital equals the eye, which is very high up, lateral, 3.4 times in the head; the least depth of the caudal peduncle is 2.16 times in the head and 1.66 times in its own length.

The mouth is small, the posterior angle of the maxillary beneath the front edge of the pupil; the teeth are typical of the genus. The predorsal scales are cycloid and smaller than the ctenoid scales on the rest of the body.

The dorsals and anal are low, the first dorsal not reaching the second when depressed, and the second dorsal and anal falling far short of reaching the caudal; the first dorsal spine is 1.6 times in the head; the highest second dorsal and anal rays equal the depth; the pointed pectoral extends to a vertical from the anus, 4.4 times in the length; the ventral is an almost circular disk, 6.6 times in the length or 1.6 times in the head.

The color in alcohol is nearly white, with a broad black band below the first dorsal, another from the second dorsal to the anal; the top, snout, and sides of the head black, and the caudal black with a narrow white upper and lower margin; a blackish brown stripe extends from behind the eye to below the second dorsal and a smaller one from the eye to the dorsal origin; the dorsals and anal are margined in front with white, the remainder black; the pectoral base is black, the fin colorless with crossbars of blackish dots; the central portion of the ventrals is black, the remainder colorless. A blackish brown stripe on the middle of the side connects the black crossbands; it is most evident above the anal and before the caudal blotch.

Here described from the type and only specimen, 26.5 mm long, or 33.5 mm including the caudal, taken on the reef at Gorror, one of the Pelew Islands.

BLENNIDÆ

Genus LEMBEICHTHYS novum

Dorsal 68–70; anal 50–55.

The body is elongate, tapering, naked, with the caudal separate from the dorsal and anal; the dorsal is of flexible spines, its origin over the opercle; the origin of the anal is in the anterior portion of the body, the length of the anal more than twice that of the head and trunk together; the ventrals are very small, of two rays, inserted beneath the hind margin of the opercle, distinctly in advance of the pectoral. The head is deeper and broader than the body, without tentacles or barbels, the snout blunt, the mouth inferior; the teeth are in one row, fixed, different in the two jaws, those of the lower jaw with arrowlike tips; there is a large pair of posterior canines in the lower jaw, as in *Petroscirtes*. The gill opening is restricted to a small opening above the upper angle of the pectoral base. Branchiostegals apparently 5.

Type species, *Lembeichthys celebesensis* sp. nov.

Named from the type locality, Lembeh Strait, Celebes.

From *Pholidichthys* Bleeker, to which it is closely related, it differs in the dentition, and in having the caudal fin entirely free from the other fins.

LEMBEICHTHYS CELEBESENSIS sp. nov. Plate 1, fig. 3.

Dorsal 68–70; anal 50–55; caudal with 11 rays plus 2 accessory rays on both the upper and lower margins.

The depth is 15.7 times, the head 7.85 to 8.46 times, the caudal 11 times, the pectoral 12.2 to 12.5 times in the length; the head and trunk together are 2.4 to 2.9 times in the tail, which is 70 to 74.5 per cent of the total.

The head is broader and deeper than the trunk or tail, with a broad, blunt, projecting snout; the eye is 3.33 to 3.6 times, the snout 4.1 to 5.4 times in the head; the interorbital equals the eye; the mouth is inferior and rather large, extending beneath the anterior portion of the pupil; there are 20 or 22 flat incisorlike teeth in the upper jaw, the end tooth on each side pointed and a little larger than the others; there are 22 teeth in the lower jaw, their tips shaped like arrowheads; the two large curved canines equal the diameter of the pupil in length.

The first few dorsal spines are low, those following are highest, $2\frac{1}{3}$ in the head, but most of the fin is of nearly uniform height with the anal, 3.5 times in the head. The pectoral is pointed; the caudal of one specimen was forked but has been damaged; the other was nearly truncate; the minute ventral is 7 times in the head.

The color in alcohol is pale tan, the lower half sprinkled with reddish brown specks, and with more or less silvery sheen on the sides of the head, trunk, tail, and yellow belly; there are five dark brown spots on the dorsal region beneath the dorsal, the first above the anal origin; the snout is dusky and the area between the eyes and dorsal origin is dark brown. The dorsal and anal are pinkish brown, densely dotted with dark brown specks, and with a black margin. The caudal has a large red-brown basal spot, the rest of the fin white; the pectorals and ventrals are also white.

Here described from the type and paratype, both 55 mm in length, collected at Lembeh Strait, Celebes. The type is much bulkier than the paratype and has a longer head and trunk.

CIRRIPECTES CANINUS sp. nov.

Dorsal XII, 12; anal 15; ventral 3; pectoral 15. The head equals the depth, 3.28 times in the length; the caudal is 4.6 times, the pectoral 2.875 times in the length; the eye is 2.9 times, the snout and interorbital each 3.5 times in the head; the depth of the caudal peduncle equals the eye; the ventral is 1.75 times in the head.

The compressed ovate body is deepest just behind the pectoral base; the caudal peduncle is entirely free, its length a trifle more than its depth. The greatest width of head equals that of the body, 1.63 times in the head. The dorsal profile of the head descends in a nearly straight angle of 45° from above the middle of the eye to the tip of the snout. The mouth is small, oblique, the posterior angle of the maxillary beneath the front margin of the eye. The lower jaw has four large hooked canines near the symphysis, with a single row of very small teeth behind them; the upper jaw has four similar but much smaller canines, with a short row of fine teeth behind.

On the nape is a row of 26 tentacles, some of them broad and bifid; the anterior nostril has a short broad fringed tentacle; there is no orbital tentacle, no papillæ or tentacles on the lips or chin. The gill opening is nearly vertical and narrower than the pectoral base. The short lateral line extends to a point

above the middle of the pectoral. The dorsal begins above the hind margin of the preopercle, the second dorsal midway between the hind margin of the eye and the caudal base; the first dorsal is broken, but the height is about 1.75 times in the head; the second dorsal is highest anteriorly, the first ray 2.33 times in the head. The anal origin is midway between the front margin of the eye and the caudal base, its height equal to that of the soft dorsal; the pectoral extends to a point above the fourth anal ray; the caudal is rounded, its central rays longest.

The color in alcohol is yellow with large brown spots between the pectoral and dorsal, and similar but much smaller spots covering the entire head and pectoral base; the dorsal has 10 blackish brown spots or vertical bands; the pectoral is brown spotted, with black tips; the other fins are colorless.

Described from the type and only specimen, caught by electric light, at Ternate, one of the Moluccas.

PETROSCIRTES GORRORENSIS sp. nov.

Dorsal 40; anal 24; pectoral 14; caudal 11, plus an accessory ray on the upper and lower margins.

The depth is 7.2 to 7.3 times, the head 4 to 4.1 times, the caudal 6.5 to 7 times in the length. The snout, interorbital, and eye are approximately equal, 3.8 to 3.9 times in the head; the curved mouth is of moderate size, not reaching the eye; there are 10 or 12 teeth on each side of the upper jaw, with a small posterior canine; the large curved canine of the lower jaw equals the pupil.

The elongate slender body tapers gradually from above the pectoral origin to the caudal base; the least depth of the caudal peduncle is 3.66 to 3.4 times in the head; the head is elongate, conical, pointed, without tentacles or barbels, the gently convex snout projecting slightly beyond the mouth. The low dorsal begins above the posterior margin of the preopercle, and is highest in the posterior half, its height 2.4 to 2.5 times in the head; the anal is a little lower, 3 to 3.16 times in the head; the bluntly rounded pectoral is 1.9 to 2 times in the head; the ventral is 2.7 times in the head.

The color in alcohol is brown with a white stripe (blue in life) from the eye to the pectoral base and continuing onto the base of the caudal; at right angles to the white stripe are ten white vertical bars, the first behind the pectoral, the last at the posterior end of the dorsal; these bars extend from the top of the dorsal to the longitudinal stripe and on below it a slight distance

but diagonally backward; the dorsal has a fine white marginal line and a narrow white submarginal stripe; the anal is dark brown on the outer half, much paler basally; the caudal and pectoral are colorless, the ventrals colorless or faintly brown.

Described from the type, 44 mm long, from the reefs surrounding Gorror, one of the Pelew Islands, and a paratype 39 mm long from Madang, on the north coast of New Guinea.

This species is close to *Petroscirtes rhinorhynchus* Bleeker, but differs in fin rays, dentition, and color markings.

MUGILIDÆ

MYXUS MALAYANUS sp. nov.

Dorsal IV–I, 8; anal III, 9; the scales are very deciduous, their number uncertain, 34 to 38 longitudinally, 12 transversely, 20 or 21 before the first dorsal.

The type, 35 mm long, and a paratype 34 mm long, have the depth 3.8 to 3.9, the head 3.67 to 3.77, the caudal 4.35, the pectoral 5.8, the ventral 7 times in the length; the eye is 3, the snout 3.15, the least depth of the caudal peduncle 2 times in the head. The first and second dorsal and anal are approximately equal in height, 8.75 times in the length.

The body is much compressed, deep, the dorsal profile convex from the dorsal origin to the snout tip; the first dorsal origin is a trifle nearer the caudal base than the tip of the snout and beneath the first anal ray. The preorbital is serrated on its anterior margin, and more finely serrate on its lower truncate border; the protractile mouth is nearly vertical, with thin lips and a single symphysial knob; there is a single row of teeth in the upper jaw and a few teeth in the lower jaw near the symphysis; the vomer has a patch of very minute teeth with larger teeth on the palatines.

The color in alcohol is bright silver, the dorsal region brown; the first dorsal is dark brown; the second dorsal is colorless on the outer portion, the rest of the fin black; the caudal has a broad basal dark brown crossbar, the remainder colorless; the other fins are all colorless; the pectoral has a trace of a dark spot at its axis.

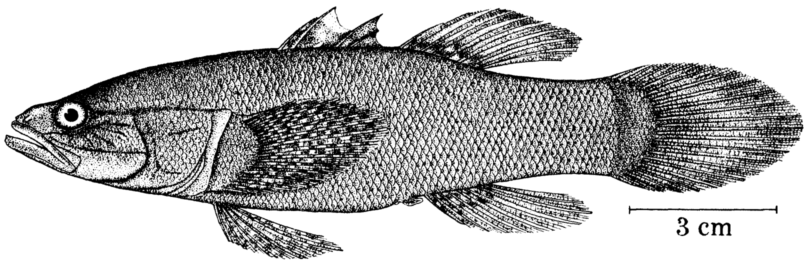
Described from the type, 35 mm long, and 5 paratypes 26 to 34 mm long, caught by electric light at the north end of Celebes.

This species differs markedly in scalation from *M. elongatus* and seems to be distinct from *M. biraræ* Duncker and Mohr.

ILLUSTRATION

Plate 1

FIG. 1. *Lizettea pelewensis* sp. nov.
2. *Macrodontogobius wilburi* sp. nov.
3. *Lembeichthys celebesensis* sp. nov.



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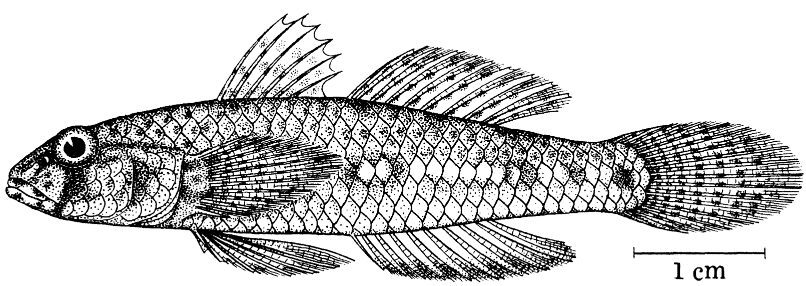

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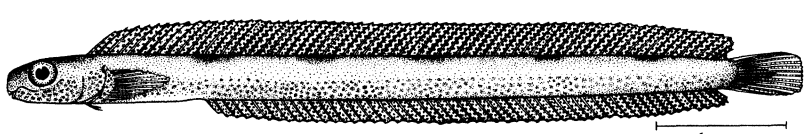

3

PLATE 1.

REVIEW OF PHILIPPINE PIGEONS, I: THE GENUS PHAPITRERON [1]

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TWO TEXT FIGURES

INTRODUCTION

The present paper is a review of the genus *Phapitreron,* based on a systematic study of the specimens in the collection of birds of the Philippine Bureau of Science, Manila.

There have been constant requests for identification of Philippine pigeons, due largely to the recent enforcements of the existing game laws and to the demand abroad for live and stuffed specimens of these birds. The confusing nomenclature in the literature of the genus prompted the writer to undertake this study.

REVIEW OF LITERATURE

Besides the papers of Temminck, Bonaparte, Sundevall, Walden, and others mentioned in synonymies of this paper, a few other publications may be considered important.

Salvadori (1893), in studying the pigeons in the collection of birds in the British Museum, enumerated the four species then known and adopted the genus *Phabotreron* (=*Phapitreron*). He described as new *Phabotreron occipitalis* with Basilan as type locality, declaring it distinct from *P. brevirostris* Tweeddale with which it was formerly identified. In addition to these two species, *P. amethystina* (Bonaparte) from Luzon, Samar, Leyte, Dinagat, Panaon, and Mindanao; *P. leucotis* (Temminck) from Luzon and Mindoro, and *P. nigrorum* Sharpe from Negros, Cebu, Guimaras, and Panay were enumerated.

The activities of Bourns and Worcester (1894) resulted in four new "species;" namely, *P. cinereiceps* from Tawitawi, *P. brunneiceps* from Basilan, *P. frontalis* from Cebu, and *P. maculipectus* from Negros.

[1] The writer is under obligation to Director Frederick N. Chasen, of the Raffles Museum, Singapore, for going over the manuscript.

All these described species were enumerated by McGregor and Worcester (1906) in their Hand-list under *Phapitreron* and were also included by McGregor (1909) in his Manual of Philippine Birds. To the last list was added *P. albifrons* McGregor from Bohol and Siquijor.

Mearns (1909) described *P. samarensis* from the birds collected by Dr. F. S. Bourns in Samar.

In consonance with the suggestion of Hartert and Goodson (1918), Hachisuka (1930) retained *leucotis* as a species with eight subspecies. *Phapitreron amethystina* was preserved as a distinct species with six subspecies. In the present paper the arrangement used by Hachisuka is adopted, but the race *mindorensis* is considered to be a synonym of *leucotis, limucon* of *nigrorum,* and *samarensis* of *albifrons* in the *leucotis* group, while *polillensis* is regarded as a synonym of *amethystina* in the *amethystina* group. *Phapitreron cinereiceps* is rated a distinct species as originally described. Two new subspecies of *amethystina* are described.

Genus PHAPITRERON Bonaparte

Pigeons of the genus *Phapitreron* are endemic, presenting an interesting local distribution. They have not been recorded in the Batanes, the Babuyanes, or the Palawan group. The genus may be described as follows:

Arboreal pigeons, wing about 110 to 160 mm long. Sexes alike externally; their colors nearly uniform brown with a dark inferciliary line extending between the gape and nape; a wide irridescent band of purple, bluish green or both on hind neck; olivaceous gloss on the greater part of back; bill with an arched swelling anteriorly; nostrils inconspicuous in anterior aspect due to flat or seedlike covering; rectrices graduated, rounded and with gray tips which are more distinct underneath; under tail coverts gray, cinnamon buff, or sayal brown;[1] tarsus partly feathered; soles broad, that of hind toe broadest.

In this paper the genus *Phapitreron* is divided into three species.

Key to the species.

a^1. Culmen less than 20 mm.
 b^1. Band on hind neck bluish green; under tail coverts gray...... *leucotis.*
 b^2. Band on hind neck purple; under tail coverts gray........ *cinereiceps.*
a^2. Culmen 20 mm or more; band on hind neck purple.......... *amethystina.*

[1] In this paper specific color names are from R. Ridgway, Color Standards and Color Nomenclature. Washington (1912).

SPECIES 1. PHAPITRERON LEUCOTIS (FIG. 1).

Culmen less than 20 mm; dominant color of band on hind neck metallic bluish green, under tail coverts gray. Habitat in open, noncommercial forest.

Key to the subspecies.

a^1. Line below dark inferciliary white.
  b^1. Forehead whitish buff.
    c^1. Nape brick red.
      d^1. Chin cacao brown. (Basilan.) .... *occipitalis.*
      d^2. Chin paler than cacao brown. (Mindanao.) .... *brevirostris.*
    c^2. Nape brown with slight tinge of reddish brown. (Samar, Bohol, Biliran, and Siquijor.) .... *albifrons.*
  b^2. Forehead brownish gray. (Luzon, Verde, Mindoro, and Alabat.) *leucotis.*
a^2. Line below dark inferciliary pale fulvous. (Tablas, Sibuyan, Ticao, Masbate, Panay, Negros, and Cebu.) .... *nigrorum.*

PHAPITRERON LEUCOTIS LEUCOTIS (Temminck).

Columba leucotis TEMMINCK, Pl. Col. (1823) 189.
Phabotreron leucotis SALVADORI, Cat. Bds. Brit. Mus 21 (1893) 67.
Phapitreron leucotis MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.
Phapitreron leucotis leucotis HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.
Phapitreron leucotis mindorensis HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.

Type locality: Manila, Luzon.

Specimens from Luzon, Mindoro, Verde, and Alabat were examined.

Measurements of 31 males and 26 females, in millimeters.

	Extremes.	Mean.
Wing	123–138	130.75
Tail	85–107	100.83
Culmen	14–16	14.17
Tarsus	17–19	18.00

A white line extends from about the anterior third and immediately below the dark inferciliary line and lies parallel throughout its length posteriorly. Forehead mouse gray, becoming dark with purplish gray tinge on crown and nape; chin and throat pinkish cinnamon; under tail coverts light gull gray.

In the present arrangement the race *leucotis* includes specimens from Mindoro which Hachisuka (1930) identified as *P. l. mindorensis*. The retention of *leucotis* is the result of the examination of four males and one female from Balete, Rio Baco, and one from Puerto Galera, both in Mindoro. One specimen

FIG. 1. Map of the Philippine Islands showing hypothetical distribution of the races of *Phapitreron leucotis*. *1. Phapitreron leucotis leucotis*, *2. Phapitreron leucotis nigrorum*, *3. Phapitreron leucotis albifrons*, *4. Phapitreron leucotis brevirostris*, *5. Phapitreron leucotis occipitalis*.

(B. S. No. 4894) from Balete, Rio Baco, was made the type of the subspecies by Hachisuka. It is true that the type specimen "has more purplish shine on the back, tail, and wing coverts than the typical *leucotis* of Luzon." However, in this particular respect the holotype is different from the paratypes, thus it does not represent the typical form but indicates merely an individual variation that is not worthy of subspecific designation. The paratypes are similar in all respects to those from Luzon. In addition the characters indicated in the holotype of *P. l. mindorensis*, although slightly intense, are also obtained in a few specimens from Peñablanca, Cagayan Province, Luzon, and from Alabat Island on the east side of Luzon from which specimens of normal *P. l. leucotis* were examined.

PHAPITRERON LEUCOTIS NIGRORUM (Sharpe).

Phabotreron nigrorum SHARPE, Trans. Linn. Soc. Zool. I (1877) 346, 353.

Phapitreron nigrorum MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.

Phapitreron leucotis limucon HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.

Phapitreron leucotis nigrorum HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 147.

Type locality: Negros.

Specimens from Negros, Panay, Cebu, Masbate, Ticao, Sibuyan, and Tablas Islands were examined.

Measurements of 13 males and 9 females, in millimeters.

	Extremes.	Mean.
Wing	120–131	125.13
Tail	86–100	94.18
Culmen	13–16	14.5
Tarsus	16–17	16.10

The white line below the inferciliary line in other races of *leucotis* replaced by pale fulvous. Forehead mouse gray as in *P. l. leucotis;* chin and throat pale ochraceous tawny.

To this race have been restored the specimens from Badajoz (nec Badajig), Tablas Islands, which Hachisuka (1930) described as *P. l. limucon.*

In separating the race *limucon* from *nigrorum* Hachisuka used the larger size of the former from Tablas as the sole criterion. He says, "the present race is nearest to *nigrorum* in coloration,

but its larger size can easily be recognized while Negros and Panay specimens never seem to overlap in measurement." In this study the measurements in millimeters of 11 specimens (7 males and 4 females) from Badajoz were found to be as follows:

	Extremes.	Mean.
Wing	122–131	126.04
Tail	86–100	94.62
Culmen	14–16	14.72
Tarsus	16–17	16.31

On the other hand, the results of measuring 11 specimens (6 males and 5 females) from Sibuyan, Ticao, Masbate, Negros, and Cebu (localities of *P. l. nigrorum* according to Hachisuka), are as follows, in millimeters:

	Extremes.	Mean.
Wing	120–127	124.6
Tail	91–100	94.6
Culmen	13–16	14.27
Tarsus		16.0

From the measurements indicated above it can be seen that the wing measurements of birds from Badajoz overlap those of the birds from other places. The difference in the mean of these measurements is due to two birds from Badajoz having wing lengths of 127 and 131 mm, respectively, and to the wing of one bird from Panay with a length of 120 mm. More material from those places will surely yield uniform results.

PHAPITRERON LEUCOTIS ALBIFRONS McGregor.

Phabotreron brevirostris STEERE, List Phil. Bds. & Mammals (1890) 24.

Phapitreron albifrons MCGREGOR, Philip. Journ. Sci. § A 2 (1907) 317.

Phapitreron samarensis MEARNS, Proc. U. S. Nat. Mus. **36** (1909) 436.

Phapitreron leucotis albifrons HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 147.

Phapitreron leucotis samarensis HACHISUKA, Contrib. Bds. Phil. **1** (1932) 179.

Type locality: Tagbilaran, Bohol.

Specimens from Bohol, Siquijor, Biliran, and Samar Islands were examined.

Measurements of 23 males and 14 females in millimeters.

	Extremes.	Mean.
Wing	120–130	124.11
Tail	85–96	91.08
Culmen	12–15	13.87
Tarsus	16–17	16.36

White line below dark inferciliary as in *P. l. leucotis*. Resembling *P. l. brevirostris* and *P. l. occipitalis* but with less purple gloss on breast. Forehead pale pinkish buff blending gradually into mouse gray of crown; nape paler than sorghum brown. Chin pale tilleul buff gradually becoming light brown on throat.

Upon careful examination of 14 specimens from Samar (Wright), 2 from Biliran, 19 from Bohol (Tagbilaran, Sevilla, and Guindulman), and 2 from Siquijor the writer was convinced that all these birds belong to one race. Again, variable characters may lead to the establishment of a new race when only a few specimens are examined. This can be solved only by examination of a number of specimens from both places. The color of the underparts of the pigeons examined from Wright ranges gradually from brown in those described by McGregor (1907) to those with a medium shade of coppery reflections typified by *P. samarensis* Mearns (1909). The specimens from Siquijor and Bohol possess the same characters. Similar overlapping of colors on the upper surface was observed in all the specimens examined. Because *albifrons* (1907) antedates *samarensis* (1909), the latter is held a synonym of the former. It is very probable that specimens from Leyte belong to this race.

PHAPITRERON LEUCOTIS BREVIROSTRIS (Tweeddale).

Phabotreron brevirostris TWEEDDALE, Proc. Zool. Soc. (1877) 549.

Phapitreron brevirostris McGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.

Phapitreron leucotis brevirostris HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 147.

Type locality: Pasonanca (nec Pasnanaca), Zamboanga, Mindanao.

Specimens from Agusan, Cotabato, Davao, and Zamboanga were examined.

Measurements of 7 males and 13 females, in millimeters.

	Extremes	Mean.
Wing	115–129	121.76
Tail	85–96	91.20
Culmen	15–16	15.39
Tarsus	14–16	15.09

White line below dark inferciliary as in *P. l. leucotis*. Resembles closely *P. l. occipitalis* except the nape which is dull Indian purple. The chin is very slightly paler than the cacao brown of *occipitalis*.

PHAPITRERON LEUCOTIS OCCIPITALIS (Salvadori).

Phabotreron brevirostris TWEEDDALE, Proc. Zool. Soc. (1879) 73.
Phabotreron occipitalis SALVADORI, Cat. Bds. Brit. Mus. 21 (1893) 68.
Phapitreron occipitalis MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.
Phapitreron leucotis occipitalis HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.

Type locality: Basilan.

Measurements of 2 males and 5 females, in millimeters.

	Extremes.	Mean.
Wing	119–125	121.28
Tail	84–93	87.28
Culmen	15–16	15.85
Tarsus		15.00

White line below dark inferciliary as in *P. l. leucotis*. Similar to *brevirostris* except the nape which is hydrangea red. Chin cacao brown.

SPECIES 2. PHAPITRERON CINEREICEPS

Culmen less than 20 mm, dominant color of band on hind neck purple; under tail coverts gray. Habitat dense, virgin forest.

PHAPITRERON CINEREICEPS (Bourns and Worcester).

Phabotreron cinereiceps BOURNS and WORCESTER, Minn. Acad. Nat. Sci. Occ. Papers 1 (1894) 8.
Phapitreron cinereiceps MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.
Phapitreron amethystina cinereiceps HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.

Type locality: Tawitawi.

Cotype (female) examined. "Top of head, nape and sides of neck clear ashy gray, slightly washed with rufous on forehead; hind neck amethystine as in *P. amethystina;* back, rump and upper tail-coverts brown with bronze reflections, the tail coverts slightly more ruddy than back." Kaiser brown of breast less intense on chin and throat. Under tail coverts gray. General appearance of upper surface closer to *P. amethystina* than to *P. leucotis,* under surface vice versa. Wing, 131 mm; tail, 98; culmen, 16; tarsus, 15.

SPECIES 3. PHAPITRERON AMETHYSTINA (FIG. 2)

Culmen 20 mm or over, dominant color on back purple, under tail coverts gray or cinnamon. Habitat dense, virgin forest.

FIG. 2. Map of the Philippine Islands showing hypothetical distribution of the races of *Phapitreron amethystina. 1. Phapitreron amethystina amethystina, 2. Phapitreron amethystina maculipectus, 3. Phapitreron amethystina frontalis, 4. Phapiteron amethystina celestinoi, 5. Phapitreron amethystina mindanaoensis, 6. Phapitreron amethystina brunneiceps.*

Key to the subspecies.

a[1]. Under tail coverts cinnamon.
  b[1]. Under surface light gray.
    c[1]. Tail less than 100 mm. (Basilan.) .... *brunneiceps.*
    c[2]. Tail more than 110 mm. (Negros.) .... *maculipectus.*
  b[2]. Under surface brown.
    c[1]. Neck dark violet, in adults distinctly sheeny.
      d[1]. Under tail coverts sayal brown. (Bohol.) .... *celestinoi.*
      d[2]. Under tail coverts cinnamon buff. (Surigao, Agusan, Davao.) *mindanaoensis.*
    c[2]. Neck paler than violet, in adults sheeny against light. (Luzon, Polillo, Alabat.) .... *amethystina.*
a[2]. Under tail coverts gray. (Cebu.) .... *frontalis.*

PHAPITRERON AMETHYSTINA AMETHYSTINA Bonaparte.

Phapitreron amethystina BONAPARTE, Compt. Rend. 40 (1855) 214.
Phaps amethystina GRAY, List Bds. Brit. Mus. (1856) 62.
Chloroenas amethystina SCHLEGEL, Mus. Pays-Bas. (1873) 80.
Phabotreron amethystina WALDEN, Trans. Zool. Soc. 9 (1875) 214.
Phapitreron amethystina amethystina HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.
Phapitreron amethystina polillensis HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.

Type locality: Philippines. Bonaparte did not indicate from which part of the Archipelago his specimen was obtained. Walden (1875), in recording *amethystina* and *P. leucotis* from Luzon, Guimaras, and Negros, was the first to indicate a specific locality for the species. The same author (p. 125) expressed an idea that the specimen described by Bonaparte perhaps came from Luzon. In the absence of evidence to the contrary, and for purposes of the present study, Luzon is taken as the type locality of the subspecies *amethystina.* Hachisuka (1930) appears to have the same opinion.

Specimens from Luzon, Polillo, and Alabat Islands were examined.

Measurements of 13 males and 14 females, in millimeters.

	Extremes.	Mean.
Wing	137–153	144.81
Tail	100–119	109.18
Culmen	20–22	21.07
Tarsus	19–23	20.95

White line, nearly pale pinkish buff, equal in length with dark inferciliary, lying parallel and below this from gape to nape; hind neck manganese violet, sheeny when held toward

the light; under tail coverts cinnamon buff, the tips of feathers in middle abdomen of the same shade.

In this study only specimens from Luzon, Alabat, and Polillo Islands are included in the race *amethystina*. It is very likely that the birds from Samar belong to this race as one young specimen I studied from Wright tends to show, but final decision should await examination of more material. It is also probable that specimens from Masbate and Leyte belong to this race.

In making *P. a. polillensis* Hachisuka (1930) a synonym of the present race, I base my action on specimens from Lucban, Tayabas. Six of 14 birds from Polillo are distinctly larger than the rest. The specimens from Lucban are also large. The color of the head is the same as in other races of this species except *maculipectus* and *brunneiceps*. The type of *P. a. polillensis* (B. S. 7037) is similar to the birds from Luzon except that it is larger than some of them. The paratypes, however, are also smaller than the holotype.

PHAPITRERON AMETHYSTINA MACULIPECTUS (Bourns and Worcester).

Phabotreron maculipectus BOURNS and WORCESTER, Minn. Acad. Nat. Sci. Occ. Papers 1 (1894) 10.

Phapitreron maculipectus MCGREGOR and WORCESTER, Hand-List Bds. Phil. Is. (1906) 10.

Phapitreron amethystina maculipectus HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.

Type locality: Negros.

Specimens from Occidental Negros were examined.

Measurements of 6 males and 3 females, in millimeters.

	Extremes.	Mean.
Wing	142–148	144.85
Tail	118–127	123.14
Culmen	20–22	20.98
Tarsus	21–23	22.14

White stripe below dark inferciliary as in *P. a. amethystina*. Below white stripe is another dark stripe. "Under surface ashy gray. Cheeks fulvous brown; chin and throat more ruddy brown; breast clear ashy gray, each feather having an edging distinctly lighter than its center, producing a beautiful mottled appearance," middle abdomen pale cinnamon buff, intermediate between breast and undertail coverts. Undertail coverts cinnamon buff.

PHAPITRERON AMETHYSTINA FRONTALIS (Bourns and Worcester).

Phabotreron frontalis BOURNS and WORCESTER, Minn. Acad. Nat. Sci. Occ. Papers 1 (1894) 10.

Phapitreron frontalis MCGREGOR and WORCESTER, Hand-List Bds. Phil. Is. (1906) 10.

Phapitreron amethystina frontalis HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 146.

Type locality: Cebu.

Cotype examined.

One male, wing, 144 mm; tail, 112; culmen, 20; tarsus, 18.

Line below dark inferciliary indistinct; hind neck pansy violet with royal purple gloss. Under surface olive brown as in *P. a. maculipectus,* intermediate between *P. a. brunneiceps* and *P. a. celestinoi.* "Under-tail coverts ashy gray, slightly tipped with fulvous."

PHAPITRERON AMETHYSTINA BRUNNEICEPS (Bourns and Worcester).

Phabotreron brunneiceps BOURNS and WORCESTER, Minn. Acad. Nat. Sci. Occ. Papers 1 (1894) 9.

Phapitreron brunneiceps MCGREGOR and WORCESTER, Hand-list Bds. Phil. Is. (1906) 10.

Phapitreron amethystina brunneiceps HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.

Type locality: Basilan.

Two males, wing, 134, 137 mm; tail, 92, 99; culmen, 20, 21; tarsus, 16, 17.

"Amethystine spot on hind neck less blue than in *P. a. amethystina.* Chin and throat grayish fulvous; breast pearly ash." Middle abdomen, flanks, thighs, and under tail coverts cinnamon buff like the under tail coverts of *P. a. maculipectus.*

PHAPITRERON AMETHYSTINA CELESTINOI subsp. nov.

Phapitreron amethystina MCGREGOR, Philip. Journ. Sci. § A 2 (1907) 317.

Phapitreron amethystina amethystina HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.

Type.—Male adult, No. 11496, Bureau of Science collection, Sevilla, Bohol; March 21, 1906; A. Celestino and M. Canton, collectors.

Subspecific characters.—Like typical *amethystina* from Luzon, Mindoro, Polillo, Alabat, and Samar, but with a darker shade of purple on the hind neck. From specimens of *P. amethystina* from Agusan, Surigao, and Davao, which it also very closely resembles, it differs in the color of the under tail coverts which

is cinnamon. From *P. a. maculipectus* of Negros, *P. a. brunneiceps* of Basilan, and *P. a. frontalis* of Cebu, it differs distinctly in the darker color of the underparts.

Range.—The distinctness of the races found in Negros, Cebu, Samar, and northern Mindanao suggests the probability that this form is confined to Bohol.

Description of type.—General color brown; forehead drab gradually changing into fuscous of crown and nape; circum-ocular area including cheeks and auriculars naked forming a subconical appearance that rests on a dark inferciliary line that extends from gape to nape. Narrower pale ochraceous buff line lies beneath dark inferciliary, the two lines running the same length. Hind neck prune purple with sheeny dark violet shade. Rest of upper surface bister with greenish clove brown gloss. Chin and throat army brown; breast, flanks, and thighs clove brown; abdomen slightly paler than breast, fringes with a wash of cinnamon buff; under tail coverts sayal brown, distal fifth of tail feathers pale olive-gray underneath. Wing, 146 mm; tail, 120; culmen, 21; tarsus, 20.

This subspecies is named for the late Mr. Andres Celestino, Filipino ornithological collector, through whose hands many Philippine birds passed before becoming known to science. Those birds are now scattered in many museums all over the world.

PHAPITRERON AMETHYSTINA MINDANAOENSIS subsp. nov.

Phabotreron amethystina TWEEDDALE, Proc. Zool. Soc. (1877) 832.
Phapitreron amethystina MCGREGOR, Hand-list Bds. Phil. Is. (1906) 10.
Phapitreron amethystina amethystina HACHISUKA, Contrib. Bds. Phil. No. 2 (1930) 145.

Type.—Male adult, No. 12362, Bureau of Science collection; Butuan, Agusan, Mindanao; September 26, 1907; A. Celestino, collector.

Subspecific characters.—Resembles closely *P. a. celestinoi* of Bohol, but the under tail coverts cinnamon buff. From typical *amethystina* of Luzon, Mindoro, Polillo, Alabat, and Samar it differs only in the degree of purple of hind neck which has a darker shade of blue. Hind neck of specimens from Luzon, etc., has a darker shade of red. Like *P. a. celestinoi*, it differs distinctly from *P. a. maculipectus* of Negros, *P. a. brunneiceps* of Basilan, and *P. a. frontalis* of Cebu in the darker color of underparts.

Range.—Although the material examined is from eastern Mindanao (Surigao, Agusan, and Davao), I believe that material from other provinces in the mainland of Mindanao belong to this race.

Description of type.—General color brown; forehead and crown drab merging with fuscous of nape; hind neck sheeny cotinga purple; rest of upper surface bister with greenish clove brown gloss; circumocular area naked forming a subconical patch with the eye situated near the apical two-thirds. This patch has a narrow dark inferciliary line, which extends from the gape to the nape, as its base. An indistinct pale ochraceous buff line below and parallel to the dark inferciliary; chin and throat verona brown; breast natal brown becoming light drab but cinnamon buff fringed in abdomen and thighs. Under tail coverts cinnamon buff. Distal fifth of tail feathers mouse gray underneath. Wing, 144 mm; tail, 121; culmen, 20; tarsus, 18.

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BOURNS, F. S., and D. C. WORCESTER. Preliminary notes on the birds and mammals collected by the Menage Scientific expedition to the Philippine Islands. Occ. Papers Minn. Acad. Nat. Sci. 1 No. 1 (1894) 8–10.

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HARTERT, E., and A. T. GOODSON. Notes on pigeons. Nov. Zool. 25 (1918) 348.

MCGREGOR, R. C., and D. C. WORCESTER. A Hand-list of the Birds of the Philippine Islands (1906) 10.

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SCHLEGEL, H. Museum d' Histoire Naturelle de Pays' Bas Livr. 10 (1873) 80.

SHARPE, R. B. On the birds collected by Professor J. B. Steere in the Philippine Archipelago. Trans. Linn. Soc. London (1877) 346, 353.

STEERE, J. B. A list of the birds and mammals collected by the Steere Expedition to the Philippines, with localities and with brief preliminary descriptions of supposed new species. Ann Arbor, Mich. (1890) 24.

TEMMINCK, C. J. Pl. Col. d'Oiseaux (1823) 189.

TWEEDDALE, ARTHUR, Marquis of. Reports on the collections of birds made during the voyage of H. M. S. "Challenger"—No. II. On the birds of the Philippine Islands (1877) 549–550.

TWEEDDALE, ARTHUR, Marquis of. Contributions to the Ornithology of the Philippines.—No. XII. On the collection of birds made by Mr. A. H. Everett in the island of Basilan (1879) 73.

WALDEN, ARTHUR, Viscount. A list of birds known to inhabit the Philippine Archipelago. Trans. Zool. Soc. London 9 Part 2 (1875) 214.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Map of the Philippine Islands showing hypothetical distribution of the races of *Phapitreron leucotis.*
1. Phapitreron leucotis leucotis.
2. Phapitreron leucotis nigrorum.
3. Phapitreron leucotis albifrons.
4. Phapitreron leucotis brevirostris.
5. Phapitreron leucotis occipitalis.

2. Map of the Philippine Islands showing hypothetical distribution of the races of *Phapitreron amethystina.*
1. Phapitreron amethystina amethystina.
2. Phapitreron amethystina maculipectus.
3. Phapitreron amethystina frontalis.
4. Phapitreron amethystina celestinoi.
5. Phapitreron amethystina mindanaoensis.
6. Phapitreron amethystina brunneiceps.

NEW PHILIPPINE FRUIT PIGEONS

By CANUTO G. MANUEL

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ONE PLATE

The two new fruit pigeons that are described in this paper were noted by the writer in the collection of birds of the Philippine Bureau of Science, Manila.

An examination of fruit pigeons from the different islands of the Archipelago resulted in the discovery of some interesting forms. While conclusions on other materials cannot as yet be drawn on account of insufficiency of specimens, I am convinced that the black-chinned fruit pigeons from Batan, Camiguin, and Calayan Islands of northern Philippines represent a distinct race, which I propose to call—

LEUCOTRERON LECLANCHERI LONGIALIS subsp. nov.

Type.—Male, No. 6402, Bureau of Science collection; Batan Island, Philippine Islands, May 31, 1907; collected by R. C. McGregor and A. Celestino.

Characters.—Closely similar to *Leucotreron leclancheri leclancheri*, but wings and tail distinctly longer.

Wing, 164 mm; tail, 118; culmen, 18; tarsus, 25; middle toe and claw, 35.

Material examined.—*Leucotreron leclancheri leclancheri*, 14 specimens from Luzon Island measured:

Wing, 146.64 (138–156) mm; tail, 106.46 (100–110); culmen, 14.64 (14–16); tarsus, 20.92 (20–23); middle toe and claw, 29.28 (27.5–32).

Another fruit pigeon belonging to a new subspecies is represented by two specimens from northern Luzon. The diagnosis of this new race follows.

NEOLEUCOTRERON MERRILLI FAUSTINOI subsp. nov. Plate 1.

Type.—Male, No. 28358, Bureau of Science collection; Mount Tabuan at about 1,000 meters, Cagayan Province, Luzon, Philippine Islands, May 21, 1929, collected by Francisco S. Rivera.

Characters.—In general appearance similar to *Neoleucotreron merrilli merrilli* (McGregor) but with an occipital patch of vandyke red.

Measurements.—Wing, 168 mm; tail, 121.5; culmen, 15; tarsus, 26.5; middle toe and claw, 36.

Remarks.—The genus *Neoleucotreron* was recently established by Hachisuka[1] who used the decomposed and lengthened barbules of the secondaries as generic characters. These criteria, however, were first noted by McGregor[2] who suggested *Neoleucotreron* for a subgeneric designation.

This subspecies is named for the late Dr. Leopoldo A. Faustino, for many years palæontologist of the Bureau of Science, Manila.

[1] The Birds of the Philippine Islands. London 1 (1932) 188.
[2] Philip. Journ. Sci. § D 13 (1918) 2.

ILLUSTRATION

PLATE 1. *Neoleucotreron merrilli faustinoi* subsp. nov., male. (Drawn by M. Ligaya.)

PLATE 1.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

American conference on birth control and national recovery. Washington, D. C., 1934. Biological and medical aspects of contraception; papers and discussions presented at the Conference, at the Mayflower, Washington, D. C., January 15, 16, 17, 1934. Edited by Margaret Sanger. Washington, D. C., National committee on federal legislation for birth control, 1934. Paper, 135 pp. Price, $1.15.

American society for testing materials. A. S. T. M. standards on refractory materials. Philadelphia, Pa., American society for testing materials, 1935. 143 pp. Price, $1. To nonmembers, $0.75.

American society for testing materials. Symposium on paint and paint materials. Philadelphia, Pa., American society for testing materials, 1935. 150 pp. Price, paper cover, $1.25; cloth, $1.50.

BLAKESLEE, GEORGE H. Conflicts of policy in the Far East. New York, Foreign policy association, 1934. Paper, 56 pp. Price, $0.25.

Chemical foundation, incorporated. Future independence and progress of American medicine in the age of chemistry, by a committee of American scientists. New York city, The Chemical foundation, 1921. 80 pp. Price, $0.50.

GALLOWAY, THOMAS W. Sex and social health; a manual for the study of social hygiene. New York, The American social hygiene association, 1924. 361 pp. Price, $2.50.

GIBSON, THOS. W. The mining laws of Ontario and the Department of mines. Toronto, H. H. Ball, 1933. 141 pp.

GREGORY, Sir RICHARD A. Discovery; or, The spirit and service of science. New York, The Macmillan Co., 1929. 347 pp. Price, $2.

GUILLERMIE, A. Le chauffage par les combustibles liquides. Paris et Liege, Librairie polytechnique, Ch. Beranger, 1935. 394 pp.

JOSE, RICARDO A. R. Investigaciones sobre la eufonia en el idioma tagalo; la sinfonía de las consonantes y la antigua clasificación de las letras tagalas. Manila, Cecilio press, 1934. 32 pp.

KAPUR, S. N. A manual on the air seasoning of Indian timbers. Delhi, Manager of publications, 1934. 113 pp.

KALSEM, MILLIE E. The use of rice on the hospital menu. Chicago, Illinois, Cook county hospital, 1935. 20 pp.

LAYTON, T. B. Catalogue of the Onodi collection in the museum of the Royal college of surgeons of England. London, Royal college of surgeons of England, 1934. 131 pp.

League of nations. Health organization. European conference on rural hygiene. Geneva, 1931. vols. 1 and 2.

League of nations. Health organization. Protective measures against dangers resulting from the use of radium, Roentgen and ultra-violet rays, by Prof. Hermann Wintz . . . with the assistance of Privat-dozent Walther Rump. Geneva, 1931. 114 pp. Price, $0.75.

League of nations. Health organization. The standardization of dysentery serum. By K. Shiga, H. Kawamura and K. Tsuchiya. The Kitasato institute for infectious diseases, Tokyo, Japan. Geneva, 1924. I–II, report.

League of nations. Organisation d'hygiene. Les enquêtes entreprises en Amerique du Sud sur la mortalite infantile. Montevideo, Impr. de Dornaleche frères, 1931. 237 pp.

MONTAGUE, JOSEPH F. I know just the thing for that! New York, The John Day Co., 1934. 265 pp. Price, $2.

MORTON, JOHN N. (comp.) Re-union booklet; original Company F of the 30th United States infantry, 1901–1904; history, letters, and stories depicting army days in the Philippines as compiled by J. N. Morton, 1933. Springfield, Mo., J. N. Morton, 1934. 136 pp. Price, $2.

OKABE, TOYOKITI. Gas metabolism of kidney tissue in vitro. Kumamoto medical college, 1934.

OWINGS, CHLOE. Women police; a study of the development and status of the women police movement. New York, F. H. Hitchcock, 1925. 337 pp. Price, $2.50.

PENROSE, E. F. Population theories and their application with special reference to Japan. California, Stanford University, Food research institute, 1934. 347 pp.

Philadelphia child health society. Nutrition program and teaching outline; developed for use in the health centers and clinics of the Division of child hygiene, Dept. of public health, Philadelphia, by Anna de Planter Bowes. 2d ed. Prepared and published by the Philadelphia child health society. Philadelphia, Pa., 1934. 156 pp. Price, $1.

Philippine Islands. Bureau of Education. Guide in health education for elementary schools, for supervisors, principals, teachers and teacher-nurses. Manila, Bureau of Printing, 1934. 225 pp.

RIVERS, THOMAS M. Autonomic diseases; or, The rheumatic syndrome. Philadelphia, Dorrance & Co., 1934. Price, $3.

ROOT, Mrs. GRACE C. Women and repeal; the story of the Women's organization for national prohibition reform. New York, Harper & brothers, 1934. 217 pp. Price, $1.50.

SASTRI, HIRANANDA. A guide to Elephanta. Delhi, Manager of publications, 1934. 70 pp.

SIZELOVE, OLIVER J. Platers' guidebook; revised solutions. 4th ed. New York, The Metal industry publishing co., 1935. 64 pp. Price, $0.25.

SPAULDING, EDITH R. An experimental study of psychopathic delinquent women. New York, Published for the Bureau of Social Hygiene, by Rand McNally and Co., 1923. 368 pp.

The Rubber growers' association. Rubber and agriculture. London, The Rubber growers' association, 1934. 64 pp.

REVIEWS

Symposium on Paint and Paint Materials. American Society for Testing Materials, Philadelphia, Pa., 1935. 150 pp. Price, $1.50.

This publication practically covers the most important points of the paint industry. It begins with a discussion of the future progress of the paint business, through the efforts of research workers and producers of useful materials. Then the subject of paint specifications is treated in a comprehensive manner, and certain advantages and disadvantages of purchasing by specifications are pointed out. The application of paints to railway passenger cars and the technical aspects of testing paints, varnishes, and lacquers are well presented and thoroughly discussed.

The rest of the symposium is devoted to technical descriptions of the characteristics, varieties, and preparation of different paint materials, used as vehicles and pigments. The symposium, therefore, may be regarded as an important source of up-to-date information on the subject of paint and paint materials, and is a valuable contribution to the progress of the paint industry.—R. H. A.

The Illinois Board of Public Welfare Commissioners. The Effort for Mental Health in the State of Illinois. Journal Printing Co., Springfield, Ill., 1932. Paper, 102 pp.

The Illinois Board of Public Welfare Commissioners makes a general statement on the development of psychiatry and mental hygiene in the state of Illinois. The board recognizes notable advances and contributions to this object, but states that such gains are not always maintained and efforts are not supported by sufficient consideration of the general task.

The general conception of the plan of organization of responsibility and functions of the various agencies is illustrated in charts. The University as a center includes departments of psychiatry and general medicine, and has the function of training workers for the application of existing knowledge in all fields and for research. The functions of agencies outside the university are divided mainly into recognition of mental diseases, therapy of mental diseases, prevention of mental diseases, and promotion of mental health. The activities of each of the participating agencies are given in this report.—O. G.

Standards on Electrical Insulating Materials. American Society for Testing Materials, Philadelphia., Pa., 1935. 311 pp. Price, $1.75.

The publication seems to give the best information available at present on the methods of testing electrical insulating materials.

The different aspects of the subject are discussed in a comprehensive manner, and some of the methods and the apparatus used, as well as their arrangement, are illustrated by means of diagrams, sketches, or photographs.

The standard specifications and methods of testing compiled in this publication cover the following materials: Varnishes, solid filling and treating compounds, molding powders, sheet and plate materials, laminated tubes and round rods, natural mica, flexible varnished tubing, friction tape, rubber insulating tape, rubber gloves, rubber matting, electrical cotton yarns, silk and cotton tapes, pasted mica, and slate; also, black bias-cut varnished tape; asbestos yarns, tape and roving; untreated paper; electrical porcelain; insulating oils.

The book covers the results of the extensive research and investigation work done by Committee D–9, of the American Society for Testing Materials, in charge of electrical insulating materials.—R. H. A.

Diseases of the Skin. By R. L. Sutton and R. L. Sutton, Jr. 9th ed. rev. and enl. C. V. Mosby Co., St. Louis, Mo., 1935. 1,433 pp. (illustrated). Price, $12.50.

This book needs no introduction to lecturers and practitioners. The present edition has been enriched with new photographs and photomicrographs and presents additional information on pyodermia gangrænosum, pili torti, telangiectasia macularis, eruptiva perstans, cutis rhomboidales muchæ, cephalosporiasis, pseudoatrophoderma colli, hidrosadenitis axillaris, necrobiosis lipoidica diabeticorum, anaphylactic gangrene, granuloma fissuratum, lingual tonsillitis, and other skin diseases described by the junior author. The section on coccidioidal granuloma, tularemia, and the treatment of syphilis have also been revised.—O. G.

American Society for Testing Materials. Standards on Preservative Coatings for Structural Materials. A. S. T. M., Philadelphia, Pa. 387 pp. Price, $1.75.

This work is a compilation of standard specifications, methods of testing, and definitions on preservative coatings (other than metallic coatings) for structural materials. It is the latest work

of the Society's Committee D–1 and covers several standards having reference to various types of pigments, oils, and thinners, varnish and varnish materials, lacquers and miscellaneous materials and subjects. New standard specifications for certain types of pigments, such as titanium compound pigments, high zinc sulphide lithopone, blue lead basic sulphate, amyl acetate, etc., are also included. The methods of tests, which cover comparative hiding power, tinting strength of white pigments, and tinting strength of dry color pigment and paste, are very interesting. The pamphlet is of great value to paint manufacturers and consumers and to all interested in paints and paint materials.—R. H. A.

Testing Precious Metals; gold, silver, palladium, platinum; identifying, buying, selling. By C. M. Hoke. 2d ed. rev. and enl. Jewelers Technical Advice Co., N. Y., 1935. Paper, 60 pp. Price, $1.

This book should be of interest to those who deal in precious metals. Part I describes in plain language the use of the touchstone, and simple chemical and other physical tests for the purpose of identifying and estimating the approximate fineness of gold, silver, platinum alloys, and other precious metals.

Part II gives useful suggestions regarding the method of evaluating old jewelry, while Part III gives the meanings of common terms used in connection with precious metals and the composition of well-known alloys.—F. D. R.

Standard Methods for Testing Petroleum and Its Products. Institution of Petroleum Technologists, London, W. C., Great Britain. 228 pp.

This publication is the latest contribution of the Institution of Petroleum Technologists to the petroleum industry. It covers practically all standard methods for sampling and testing petroleum materials, describing in detail the different apparatuses used and the various steps taken in the preparation of the tests. It also discusses the points of the methods that have the greatest bearing on results. The publication is profusely illustrated with sketches showing the relation between different parts of apparatus used in the most important tests. In order to avoid possible misunderstanding regarding the significance of the results of tests, instructions are given on how the results should be expressed and interpreted.

The work is well indexed and properly arranged, and may be regarded as a valuable reference book for manufacturers and users of petroleum products.—R. H. A.

A Manual of the Common Invertebrate Animals Exclusive of Insects. By H. S. Pratt, Haverford College. Revised edition. P. Blakiston's Sons & Co., Inc., Philadelphia, Pa., 1935. 854 pp. 974 figs. Price, $7.50.

The revised edition of this important and well-known book on the classification of the Invertebrata is a great improvement over the first edition, which appeared in 1916. Many of the larger subdivisions, in fact, even entire phyla, have been rewritten in coöperation with, or with the assistance of, specialists. The nomenclatures of the species treated are brought up to date and errors of fact in the descriptions in the early edition are corrected. Many of the animals included are so cosmopolitan in distribution that although the text is perhaps primarily intended for the American student of zoölogy it can be used anywhere.

Small, but very important, groups of animals like the ctenophores, nemertineans, trochelminthes, bryozoans, and brachiopods are always a source of difficulty to a building systematist. A student working in the field or in the laboratory often meets these animals of the so-called "indefinite systematic position" and unless he has a book of this sort for ready reference he often finds himself lost. The prominence given to these small groups is an excellent feature of the text. The enumeration of the families and genera is preceded by morphological descriptions of the phylum, classes, and orders, together with definitions of terms most often used. These descriptions facilitate the use of the synoptic keys with which the book is amply supplied. The book is replete with schematic but non-the-less good illustrations which in many cases allow one to place his animal to the genus without much difficulty. The text is well adapted for use in classes of systematic marine invertebrates. It is handy in any marine laboratory where beginning students in systematic zoölogy are taught to identify collected material.—H. A. R.

THE PHILIPPINE JOURNAL OF SCIENCE

Manuscripts intended for publication in the Philippine Journal of Science should be sent to the Editor, Philippine Journal of Science, Bureau of Science, post-office box 774, Manila, P. I.

One hundred separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

The Journal is issued twelve times a year. The subscription price is 5 dollars United States currency per year. Single numbers, 50 cents each.

Subscriptions may be sent to the Business Manager, Philippine Journal of Science, Bureau of Science, post-office box 774, or to the Publications Division, Department of Agriculture and Commerce, post-office box 302, Manila, P. I., or to any of the agents listed below.

Publications sent in exchange for the Philippine Journal of Science should be addressed: Scientific Library, Bureau of Science, post-office box 774, Manila, P. I.

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The Macmillan Company, 60 Fifth Avenue, New York, N. Y.
Martinus Nijhoff, Lange Voorhout 9, The Hague, Holland.
G. E. Stechert & Co., 31–33 East 10th Street, New York, N. Y.
The Maruzen Co., Ltd., 6 Nihonbashi, Tori-Nichome, Tokyo, Japan.

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The articles in the Philippine Journal of Science are indexed in the International Index to Periodicals, New York, N. Y.

VOL. 59, NO. 3 MARCH, 1936

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1936

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 59 MARCH, 1936 No. 3

BIRDS NEW AND RARE IN THE PHILIPPINES

By RICHARD C. MCGREGOR

Chief, Publications Division, Department of Agriculture and Commerce

and

CANUTO G. MANUEL

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This paper contains notes on birds twelve species of which are now recorded in the Philippines for the first time, one species whose previous collection in this country appears doubtful, and eight that represent additional records of species rare in the Archipelago.[1]

PTERODROMA ROSTRATA TROUESSARTI Brasil.

May 24, 1926, Mr. Santos Dacia shot a male petrel on the shore of Laguna de Bay in Los Baños, Laguna Province, Luzon. It was mounted and presented to the Department of Entomology, College of Agriculture, University of the Philippines. Later the specimen was turned over to the Bureau of Science where it was dismounted.

This petrel (Bureau of Science collection, No. 26554) obviously is a straggler from New Caledonia where previous specimens are reported(1) to have been obtained. It has the following measurements: Length, 397 mm; wing, 287; tail, 122; culmen, 36; tarsus, 46. This bird must have been carried by a southeast monsoon, which is generally prevalent in the Tropics(10) south of the Equator from about April to October. Accordingly the bird traversed several islands and bodies of water before it came to the Philippines. It probably went through northeastern Aus-

[1] We are indebted to the Rev. Fr. Miguel Selga, S. J., director of the Philippine Weather Bureau, for information regarding the direction of winds at certain seasons of the year.

tralia and intervening islands northwestwardly to southeastern Borneo, thence northward until it reached the Equator. North of the Equator the wind blows from the southwest,(10) which would change the direction of its flight. By seeking refuge along the shore of eastern Borneo, the bird probably traveled northward to eastern Palawan, thence by western Mindoro to Luzon, until it located itself in an inland lake for shelter after a wearisome journey. From the appearance of the route taken by this bird, the distance covered could not have been made in only one or two months. It, therefore, probably started its journey sometime during the previous year. In this connection the records of the Philippine Weather Bureau, which show that there was no trade wind immediately previous to May 25, 1926, to favor the flight of this petrel from its native haunts, are significant. This is the first Philippine record of this species.

COOKILARIA LEUCOPTERA HYPOLEUCA (Salvin).[2]

A male white-breasted petrel (Bureau of Science collection, No. 30029) was obtained from G. Taguibao, according to whom the bird was purchased from a man who shot it along the shore of Manila Bay November 21, 1935. It was lame when Taguibao got it for mounting. This species(6) has been recorded as breeding in the Hawaiian group and Bonin Islands, and this specimen represents a new and interesting record for the Philippines.

November 10 to 20, 1935, a strong typhoon hit the northern part of Luzon. According to the Philippine Weather Bureau the typhoon originated in the Pacific Ocean (East Quadrant), which includes the habitat of this species. It is probable that the species is an aberrant visitor to Philippine waters and that this bird was driven by the typhoon to the coast of northern Luzon. From there it may have sought refuge along the western coast of Luzon until it entered Manila Bay.

PUFFINUS LEUCOMELAS (Temminck).

A male white-fronted petrel (Bureau of Science collection, No. 30027) had apparently lost its sense of direction when it struck the bright lights at Pier 7, in Manila. This, according to the night watchman on that wharf, was the cause of the unconsciousness of the bird which he caught in February, 1935. The watchman sold the bird to Mr. Fidel H. Alonte, in charge of the Manila Aquarium, from whom it was obtained for the collection.

[2] See Proc. U. S. Nat. Mus. 16 (1893) 617–618.

This petrel has the following measurements: Length, 471 mm; wing, 310; tail, 153; culmen, 48.5; tarsus, 44.5; middle toe with claw, 67.5.

The only other record of this species in the Philippines was made by Cuming in 1836,(8) also in winter, from Luzon. Cuming's bird is in the British Museum.

NYROCA FERINA (Linnæus).

An adult male pochard(13) was shot by Mr. Modesto Flores from a fishpond in Hagonoy, Bulacan Province, Luzon, November 19, 1927. The bird (Bureau of Science collection, No. 29157), which is perhaps a straggler from its winter home in China,(18) has the following measurements: Length, 475 mm; wing, 205; tail, 75; culmen, 50; tarsus, 30. A white spot at the apex of the chin is very distinct. This is the first Philippine record of this species.

PERDIX BARBATA Verreaux and Des Murs.

A bearded partridge (Bureau of Science collection, No. 30028) was presented by Mr. G. Castañeda. The bird was shot near Fort William McKinley reservation, in Balagbag, Rizal Province, September 18, 1931. It is the first known recapture of this introduced species. Mr. H. C. Whittal, to whom the introduction of the Chinese francolin into the island has been attributed, states that he and five friends brought about twenty birds of this species from Hongkong in 1915. According to him they were all liberated in several places between Balagbag and Fort William McKinley.

COTURNIX COTURNIX JAPONICA Temminck and Schlegel.

A male Japanese gray quail(15) was caught with a net by a trapper at Novaliches (near Manila), Rizal Province, Luzon, November 29, 1930. The bird was purchased by Francisco S. Rivera, who gave it to the collection. The specimen (Bureau of Science collection, No. 29861), which represents a new record for the Philippines, possesses the following measurements: Length, 170 mm; wing, 102; tail, 36; culmen from nostril, 10; tarsus, 24. The bird is perhaps a straggler from Formosa.(11)

TURNIX WORCESTERI McGregor.

A female Worcester's button quail (Bureau of Science collection, No. 8812), was obtained from a bird vender. The bird was trapped in Parañaque, Rizal Province, July 26, 1934. *Turnix worcesteri* is now definitely known to occur in the rice fields about Parañaque, a few kilometers south of Manila.

There are four specimens of this species recorded,(7) including the type. They were purchased in a local market.

SCOLOPAX RUSTICOLA Linnæus.

In a hunt for game birds with the use of a light—a common illegal practice in certain regions—a male woodcock(14) was caught in Santo Tomas, Pampanga Province, Luzon, on the night of December 4, 1929. The bird was purchased by an American, who kindly donated it to the collection. McGregor's notes on the original tag read, "Taken with light. Bill fuscous to fuscous-black at tip, base of lower mandible cartridge buff. Legs and toes drab. Nails fuscous-black." The bird (Bureau of Science collection, No. 28138) possesses the following measurements: Length, 360 mm; wing, 195; culmen, 75; tail, 83 (rectrices lacking); tarsus, 35. This is the first Philippine record of this species. This bird may have come with the snipes (*Capella megala, C. gallinago,* etc.) that winter here annually.

Mr. G. Castañeda presented us with another specimen of the woodcock shot outside the military reservation, near Fort William McKinley, Rizal Province, Luzon, September 18, 1931.

LIMNOCRYPTES MINIMA (Brünnich).

A male jack snipe(14) was shot by Francisco S. Rivera in a vacant rice field in Apalit, Pampanga Province, Luzon, November 23, 1930. It was with a number of *Capella megala* Swinhoe. It is very probable that jack snipes [3] and woodcocks (*Scolopax rusticola*) occasionally come to the Philippines with a flock of other snipes.

The jack snipe from Apalit (Bureau of Science collection, No. 29155), which constitutes an addition to the list of Philippine birds, has the following measurements: Length, 210 mm; wing, 115; culmen, 42; tail, 55; tarsus, 23.

PHILOMACHUS PUGNAX (Linnæus).[4]

An immature ruff was caught in a rice field in Bulacan Province September 9, 1929, by Francisco S. Rivera. Due to baffling characters presented by this bird (Bureau of Science collection, No. 30026), it is considered best to present its description.

Forehead buff, spotted with brownish black. Crown, indicating a young plumage, buff streaked with black. Greater and median coverts brownish buff, darker near tips. Feathers of

[3] In September, 1934, many of these birds were reported by sportmen from Laguna and Camarines Norte Provinces.

[4] We are indebted to Director F. N. Chasen, of the Raffles Museum, for identifying this young specimen.

upper surface with buffish white fringe. Dark regions glossed with light greenish brown. Three longest tertiaries barred near tips with one whitish buff acute band each. Lower back, rump, and upper tail coverts ashy brown; in general appearance similar to but darker than hind neck. Lateral upper tail coverts pure white. Rectrices smoky brown, with black submargin and white tips; three median pairs barred with black and white near tips. Chin and throat grayish white, growth distinctly juvenile. Foreneck and breast brownish buff with their distal fifth gray. The breast fades gradually into white on flanks, abdomen, and under tail coverts. Axillars white with submarginal black bars.

Bill black, flesh-colored at base of lower mandible. Tibiotarsus transversely scaled both before and behind; yellowish brown in preserved specimen. Toes webbed; web of outer with middle toe more pronounced than that of middle with inner. Inner toe slightly shorter than outer; middle longest. Hind toe elevated. Length, 275 mm; culmen, 185; tail 75; exposed tibia, 30; tarsus, 47.

This young ruff was probably a straggler from Ceylon, Tennaserim, or Assam, where the species has been recorded(16) as a winter visitor. This is a new Philippine record.

PSEUDOTOTANUS GUTTIFER (Nordmann).

This species is probably an occasional winter visitor in the Philippines although in comparatively small numbers. McGregor and Celestino obtained one male and two females November 16 and 17, 1906, in Minglanilla, Cebu Province. December 17, 1927, they obtained four males in Obando, Bulacan Province. All the birds are in winter plumage according to Stuart Baker.(16)

The known winter range of this species, according to Stuart Baker,(16) is northeastern India, Burma, Malay Peninsula, and Hainan. The records presented indicate that the Philippines is the southernmost extension of its winter range.

LARUS ARGENTATUS VEGÆ Pontoppidan.

Francisco S. Rivera and Anacleto C. Duyag obtained a female Vega herring gull(3) on the coast of Manila Bay at Obando, Bulacan Province, Luzon, October 25, 1928.

Measurements of the specimen (Bureau of Science collection, No. 27200) are as follows: Length, 535 mm; wing, 420; tail, 172; culmen, 49; tarsus, 60.

The bird is probably a vagrant from its winter home in China(18) by way of Formosa.

The only other record of this species in the Philippines is of a specimen supposed to have been obtained by B. Schmacker in

1896. The bird(3) is now in the Bremen Museum. Unfortunately, however, the accuracy of its origin is now questioned. It is contended(3) that Schmacker himself did not collect the bird in the Philippines.

HYDROPROGNE CASPIA (Pallas).

A male Caspian tern was shot by Mr. Basilio Hernandez January 4, 1931, on the shore of Manila Bay in the vicinity of Binuangan, Obando, Bulacan Province, Luzon. The bird was perhaps a straggler from Formosa where this species is believed(11) to be a resident.

It is probable that a strong northeast wind, prevalent in November, December, and January, carried this tern to the Islands.

The original label, which reads, "Bill coral red, dusky towards tip, extreme tip paler. Leg and tarsus walnut brown, joints, toes, webs, nails, black," was written by McGregor. The specimen (Bureau of Science collection, No. 26098) has the following measurements: Length, 510 mm; wing, 387; culmen, 66; tail, 135; tarsus, 40. This is the first Philippine record of this species.

GELOCHELIDON NILOTICA Gmelin.

The first Philippine record of this species was made by McGregor and party, who obtained a male bird at Puerto Princesa, Palawan, October 8, 1925. October 27, 1928, Francisco S. Rivera and Anacleto C. Duyag secured three males and three females at Obando, Bulacan Province, Luzon. F. S. Rivera collected two males at Obando August 6, 1930. Manuel obtained two females on the coast of Panay Gulf in western Occidental Negros October 8, 1933. These repeated records tend to show that this species is a regular visitor to the Philippines. The above-mentioned specimens have the following measurements:

Measurements of Gelochelidcn nilotica Gmelin.

	Average from Obando.		Palawan, male.	Average from Negros, females.
	Males.	Females.		
	mm.	*mm.*	*mm.*	*mm.*
Wing	273.0	273.6	305	285.0
Tail	149.6	112.6	139	123.5
Culmen	38.6	34.1	37	35.0
Tarsus	31.38	29.1	30	28.7

For lack of sufficient material for comparison, the subspecific designation of the Philippine form cannot now be given.

Mathews(4) recommended six subspecies for this species. He indicated the measurements of the culmen of the Javanese and of the Chinese races as 36 mm and 36 to 37 mm, respectively. The table presented above shows that the Philippine subspecies, based on the measurement of the culmen, is similar to the Javanese and the Chinese subspecies. When material is available it may be found that the Chinese, Philippine, and Javanese forms belong to the same subspecies, which perhaps breeds in China and winters in the Philippines, Borneo, and occasionally in Java.

ASIO FLAMMEUS (Pontopiddan).

Three female short-eared owls(2) were collected near Binuangan, Bulacan Province, Luzon, December 30, 1927, by McGregor and party. They are of about the same size, and one of them, measured when fresh, had a length of 37 cm. The average measurements of the skins are: Length, 367 mm; wing, 325; culmen, 30; tail, 145; claws, 27 to 29. These represent an addition to the known species of Philippine birds.

CLAMATOR COROMANDUS (Linnæus).

An interesting record of the crested cuckoo in Luzon was made by Domiciano Villaluz who obtained the bird (Bureau of Science collection, No. 29154) in Angono, Rizal Province, December 20, 1932. The only other three records of this species in the Philippines are quoted by McGregor(8) from Bourns and Worcester's manuscript, who state that Everett obtained one specimen in Mindanao, while they got one in Siquijor and one in Palawan. All these birds are in foreign institutions. This species appears to be a straggler to the Philippines.

HIRUNDAPUS CELEBENSIS DUBIUS (McGregor).

Mr. Francisco P. Domingo shot a female giant swift in Ipo, Norzagaray, Bulacan Province, Luzon, September 7, 1935. According to the collector a number of swifts were flying very high so that he was lucky in bringing one of them down.

This bird (Bureau of Science collection, No. 13409) presents an interesting case systematically. The deep steel-blue color characteristic of *Hirundapus celebensis celebensis* (Sclater) is distinct. On the other hand the color of the underside of the wings is peculiarly *H. c. dubius* (McGregor). From the description(3) it appears that *H. c. celebensis* and *H. c. dubius* differ only in minor characters, so that when sufficient numbers

are compared they may be found to be identical. However, until the status of the two subspecies is decided, this bird is tentatively named *H. c. dubius.*

Measurements of the Domingo specimen are: Wing, 222 mm; tail, 75; culmen from nostril, 7; tarsus, 19; middle toe with claw, 25.

ZANTHOPYGIA NARCISSINA (Temminck).

In 1921 McGregor (9) reported the second Philippine record of the Narcissus flycatcher, which he and Andres Celestino secured in Calayan in 1903. The first record was a male bird obtained by J. B. Steere (12) in Mindanao in 1874. Three other specimens obtained since 1903 are here reported. A female (Bureau of Science collection, No. 28748) was collected by McGregor and party at Limay, Bataan Province, November 23, 1924. In November, 1933, two males of this species were added to the Bureau of Science collection. One of these (Bureau of Science collection, No. 28859) was picked up unconscious by Mr. Wallace Adams from the floor of the building then occupied by the Fish and Game Administration. The building is close to the shore of Manila Bay, and the bird was perhaps so exhausted by its flight that it struck the wall of the building and dropped to the floor. Four days afterwards (November 7) the other bird (Bureau of Science collection, No. 28860) was obtained by Manuel from a boy who shot it with a slingshot. According to the boy the beautiful color of the bird struck his attention. The bird was perched on a branch of a citrus tree about three meters from the ground, looked sickly, and was easily killed.

PRIONOCHILUS PARSONSI McGregor.

An extension of the range of this species was noted when five birds, consisting of three males and two females were obtained by Francisco S. Rivera on Mount Irid, Rizal Province, November 16, 17, and 18, 1926. It is interesting to note that the type locality (Malinao, Tayabas) is 121° 38′ east, 14° 44′ north, while Mount Irid is 121° 20′ east, 14° 47′ north. Both places are in the Sierra Madre Mountain Range.

CHLORURA BRUNNEIVENTRIS Ogilvie-Grant.

Two male bamboo weavers were secured by Francisco S. Rivera near Majayjay, Laguna Province, Luzon. One (Bureau of Science collection, No. 26483) was obtained April 10, 1928, and the other (Bureau of Science collection, No. 26484) was collected August 27, 1929. Whitehead's (17) contention that

they were always difficult to obtain appears to be confirmed by the long interval between these records and that made by him in Mindoro in 1895, and by McGregor in 1905. The type specimen of this rare bird is in the British Museum (Natural History).

ERYTHURA TRICHROA (Kittlitz).

In 1921 McGregor(8) recorded a species of bird suspected to be *E. trichroa*. At that time he was not sure whether the species was resident or migratory. In 1934 Manuel was given a statement by a German professional bird collector, attributed to a known European ornithologist, to the effect that *E. trichroa* provides an interesting case of migratory habits in that from its home in the Solomon Islands the species winters in Mindanao. This would mean that it moves northwestward in winter crossing the Equator. Unfortunately, we are unable to locate the literature verifying this statement.

During the period from April to July, 1935, peddlers commonly sold this species in Manila. The birds are kept in small bamboo cages. According to some of the peddlers, the birds feed on the seeds of buho, *Schizostachyum lumampao,* and on weed seeds. They are caught in large numbers in many places around Manila. Undoubtedly, the species has established itself in Luzon. In a number of visits made by Manuel to boats plying between Australia and Hongkong docked in Manila harbor, these birds are observed in large cages. They were purchased in Australia, where the species is also known to occur,(5) to be sold in Hongkong. Information was obtained that occasionally local Chinese bird venders buy birds from these transient merchants. It is possible, therefore, that *E. trichroa* was introduced here through this agency.

The Indian red munia, *Amandava amandava* (Linn.), was introduced here in the same manner.

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A REVIEW OF PHILIPPINE PIGEONS, II
SUBFAMILY PTILINOPODINÆ

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The present paper contains a review of Philippine fruit pigeons belonging to the subfamily Ptilinopodinæ based on the material in the collection of birds of the Philippine Bureau of Science, Manila.

The subfamily Ptilinopodinæ is an artificial group for the reason that there are no trenchant structural characters peculiar to it. This must have caused the confusion among the early systematists of this group. The birds may, however, be described as arboreal pigeons of medium size; bill weak; distal portion of first primary attenuated; tarsus feathered for more than half its length; soles broad, that of hind toe broadest. In the Philippines four genera of pigeons may be recognized on this basis.

Judging from specimens examined and from scattered literature about this group of Philippine pigeons, it appears that more collecting is necessary for an exhaustive treatise on the subject. Among those who have had occasion to study systematically Philippine specimens of this group may be mentioned Gray, Bonaparte, Verreaux and Des Murs, Schlegel, Elliot, Oustalet, Meyer, Salvadori, McGregor, and Hachisuka. Pertinent citations of the works of these investigators are enumerated at the end of this paper.

The genus *Ptilinopus* was proposed by Swainson (1825). Strickland (1841) questioned the word on the basis of its derivation. He asked if it should not be *Ptilopus* instead.

The first application of this generic name to a Philippine bird was made by Gray (1844) when he named *Ptilonopus occipitalis.* Mitchell prepared the illustration of the bird in that publication.

Due to the growing complexity and confusion, Bonaparte (1854) split the subfamily into two series, and the series Ptilopodes into six genera. He described *Trerolæma* (=*Leucotreron*) *leclancheri,* the second Philippine representative of the group.

Unfortunately many of his proposed names were based upon immature stages of named species, thus presenting more confusion to later systematists. Confronted with the difficulties of following Bonaparte's scheme, Elliot (1878) retained the large genus (*Ptilopus*) with seventy-one species. The many specimens that Elliot examined enabled him to eliminate those names that were synonyms of valid names. Still many species were either omitted or unnecessarily included in the list. Two Philippine species, *Ptilopus occipitalis* and *P. leclancheri,* were, however, enumerated.

Oustalet (1880) described *Ptilopus marchei,* the third Philippine species of this group known.

Guillemard (1885) recorded *Ptilopus formosus* Gray (=*Ptilinopus temminckii*) from Sulu, the fourth species of the group in the Philippines.

The fifth species of the group was named by Meyer (1891) as *Ptilopus bangueyensis.*

When Salvadori (1893) prepared the catalogue of pigeons in the collection of the British Museum, he indicated Ptilopodinæ as one of the three subfamilies of Treronidæ. He also divided the genus *Ptilopus* into twelve subgenera and placed *occipitalis, leclancheri,* and *marchei* under the subgenus *Leucotreron.* Obviously, the condition of the first primary (abruptly attenuated on apical portion), the long tail, and the absence of a defined cap on the upper part of the head were used as subgeneric characters. Moreover, *Ptilopus temminckii* was placed in the subgenus *Lamprotreron,* and *P. bangueyensis* in the subgenus *Spilotreron.* Bifurcated pectoral feathers is the main character used for segregating *Lamprotreron* from *Leucotreron.* The condition of the distal portion of the first primary was used principally in separating *Spilotreron* from the two subgenera named above.

McGregor and Worcester (1906), following Sharpe, gave *Leucotreron, Lamprotreron,* and *Spilotreron* generic rank; they recorded *occipitalis, marchei,* and *leclancheri* as species of *Leucotreron; temminckii* as a species of *Lamprotreron;* and *bangueyensis* as a species of *Spilotreron.* This scheme was upheld by McGregor in a later publication (1909), then describing the pigeons of the genus *Leucotreron* as forest inhabiting, with both webs of the first primary greatly reduced in width near the tip, the tail square, and the tarsus feathered for more than half its length. In other respects the characters used by Salvadori, for the separation of subgenera, were adapted by McGregor for generic distinction. The same author (1916) described *Leuco-*

treron merrilli, the sixth species, and later (1918) suggested that *L. marchei* and *L. merrilli* be placed under the subgenus *Neoleucotreron,* the decomposed and lengthened barbs of the secondaries to be used as a diagnostic character.

Mathews (1911) used *Leucotreron* for a group of Australian pigeons, giving the normal pectoral feathers, the rather long tail, and the comparatively short under tail coverts as the basis for separation. The principal character given for the genus *Ptilinopus* is the bifurcated pectoral feathers.

Richmond (1917) brought to light that *Hæmatæna* should replace *Spilotreron.*

Hachisuka (1930) enumerated two genera with four species of Philippine ptilinopodine pigeons. In a later publication (1932), the same author enumerated four genera (*Hæmatæna, Leucotreron, Neoleucotreron,* and *Ptilinopus*) with three others and classified them under the subfamily Treroninæ. He described *Leucotreron leclancheri palawana* and raised *Neoleucotreron* to generic status with the species *marchei* and *merrilli,* citing McGregor's suggestion for his action.

In a recent paper, Manuel (1936) described the new races *Neoleucotreron merrilli faustinoi* and *Leucotreron leclancheri longialis.*

In view of the foregoing statements, *Ptilinopus* Swainson (1825) is a valid name and has priority over *Ptilopus. Leucotreron, Neoleucotreron,* and *Hæmatæna* should be segregated as distinct genera, because of the peculiar diagnostic characters each group presents.

Key to the genera of Philippine ptilinopodine pigeons.[1]

*a*¹. Pectoral feathers normal.
 *b*¹. Outer and inner webs of secondaries uniform.
  *c*¹. Webs of distal third of first primary gradually and slightly attenuated .... *Hæmatæna.*
  *c*². Webs of distal fifth of first primary abruptly and distinctly attenuated .... *Leucotreron.*
 *b*². Outer webs of majority of secondaries with barbules decomposed, lengthened, and distinctly colored........ *Neoleucotreron.*
*a*². Pectoral feathers bifurcated........ *Ptilinopus.*

Genus HÆMATÆNA Bonaparte, 1857

Distal third of first primary gradually and slightly attenuated; tail rounded; general color nearly uniform grass green;

[1] Genera and species recorded by other writers but not examined in the present study are enumerated but not discussed in this paper.

males with gray head patched with black on occiput and yellow on throat.

HÆMATÆNA MELANOCEPHALA BANGUEYENSIS (Meyer).

Ptilopus bangueyensis MEYER, Journ. für Orn. (1891) 70.
Spilotreron bangueyensis MCGREGOR and WORCESTER, Hand-list Birds Philip. Is. (1906) 11.
Ptilinopus melanocephala bangueyensis HARTERT, Nov. Zool. 10 (1903) 33.
Hæmatæna melanocephala enantia OBERHOLSER, Journ. Wash. Acad. Sci. 14 (1924) 296–297.
Hæmatæna melanospila bangueyensis HACHISUKA, Birds Philip. Is. 1 (1932) 192–193.

Mindanao, Basilan, Sulu Archipelago, Banguey, Palawan, Cagayan Sulu.

Specimens from Basilan and Jolo Islands were examined.

Measurements of Hæmatæna melanocephala bangueyensis (Meyer) based on five males and eight females.

	Extremes. mm.	Mean. mm.
Wing	115.0–124	120.1
Tail	68.0–83	80.7
Culmen	14.5–15	14.7
Tarsus	20.0–21	20.3
Middle toe and claw	24.0–27	25.3

This species has been placed in the genus *Spilotreron.* Richmond (1917), however, indicated why *Spilotreron* should be replaced by *Hæmatæna.* Some systematists adapted *melanospila* as the specific name, while others used *melanocephala; melanocephala* (1781) antedates *melanospila* (1875), and should, therefore, be used. *Hæmatæna m. bangueyensis* is the northern race of the species, as previous students have shown distinction from closely related forms to be regionally slight.

Genus LEUCOTRERON Bonaparte, 1854

Distal fifth of first primary abruptly and distinctly attenuated; general color of upper parts grass green.

Two species are recognized from the Philippines.

Key to the Philippine species of Leucotreron.

a [1]. Chin white; under tail coverts light buff, inner webs largely green. *L. occipitalis.*
a [2]. Chin black; under tail coverts light cinnamon.................. *L. leclancheri.*

LEUCOTRERON OCCIPITALIS (Gray).

Ptilonopus occipitalis GRAY, Gen. Birds 2 (1844) pl. 118.
Ramphiculus occipitalis BONAPARTE, Compt. Rend. 39 (1854) 878.

Omeotreron batilda BONAPARTE, Compt. Rend. 39 (1854) 878.
Lamprotreron porphyrea BONAPARTE, Icon. Pig. (1857) pl. 15.
Leucotreron occipitalis MCGREGOR and WORCESTER, Hand-list Birds Philip. Is. (1906) 10.
Leucotreron occipitalis occipitalis HACHISUKA, Cont. Birds Philip. No. 2 (1930) 147.

The Philippine Archipelago, except the Batanes, the Babuyanes, and the Palawan groups.

Specimens from Luzon, Mindoro, Sibuyan, Samar, Cebu, Negros, Mindanao, (Agusan, Surigao, Davao), and Basilan were examined.

Measurements of Leucotreron occipitalis (Gray) based on seventeen males and six females.

	Extremes. mm.	Mean. mm.
Wing	145.0–162.0	154.4
Tail	111.0–119.0	113.3
Culmen	14.0– 16.0	14.53
Tarsus	22.5– 26.5	23.96
Middle toe and claw	29.5– 34.0	31.1

Nearly all previous workers recognized Bonaparte as the authority for this species. Gray (1844), however, should be given credit on account of a plate that accompanied the indication.

Eight specimens from Mindanao (Surigao, Agusan, and Davao) were examined. No difference was observed between them and those from other parts of the Philippines. Hachisuka (1930) described *L. o. brevipes* from four specimens collected on Mount Apo. However, the wing measurement which Hachisuka used cannot be a valid character, as the length he gave tallies with those obtained in this study. In a later publication (1932) he revived *L. o. incognitus* (Tweeddale), making his *brevipes* a synonym of that species and indicating Mindanao as the locality. Tweeddale originally described a young female of *L. o. occipitalis* from Agusan and called it *Xenotreron incognita.* The small amount of gray on the head, which Hachisuka (1932) used for separating *L. o. incognitus* from the typical race, is, obviously, an age difference, according to the material examined in this study.

LEUCOTRERON LECLANCHERI LECLANCHERI (Bonaparte).

Trerolæma leclancheri BONAPARTE, Compt. Rend. 41 (1855) 247.
Leucotreron gironieri VERREAUX and DES MURS, Ibis (1862) 342, pl. 12.
Ptilopus hugoniana SCHLEGEL, Ned. Tijds. Dierk. (1863) 60–61.
Ptilopus leclancheri SALVADORI, Cat. Birds Brit. Mus. 21 (1893) 79–80, pl. 3.

Leucotreron leclancheri McGREGOR and WORCESTER, Hand-list Birds Philip. Is. (1906) 10.

Leucotreron leclancheri leclancheri HACHISUKA, Birds Philip. Is. (1932) 186–187.

Luzon, Lubang, Mindoro, Catanduanes, Samar, Sibuyan, Tablas, Romblon, Panay, Negros, Cebu, Bohol, Guimaras, Cagayancillo, Calamianes, Palawan.

Specimens from Luzon, Polillo, Mindoro, Romblon, Ticao, Tablas, Bohol, Biliran, Bantayan, Cagayancillo, and Semirara were examined.

Measurements of Leucotreron leclancheri leclancheri (Bonaparte) based on seventeen specimens of each sex.

	Extremes. mm.	Mean. mm.
Wing	138–155	146.1
Tail	100–114	105.1
Culmen	13– 16	14.78
Tarsus	19– 23	20.66
Middle toe and claw	27– 32	28.1

Although the head, throat, and breast are pearly gray in breeding males and largely cedar green in breeding females, various shades between these two colors are encountered in those of the different stages of both sexes. The black chin, however, is constant, while the size and appearance of the seal brown pectoral band is variable.

Considered by McGregor (1909) to range throughout the Philippine Archipelago. The validity of *Leucotreron leclancheri palawana* Hachisuka (1932), however, will eliminate Palawan and possibly Calamianes from the range of the typical race. Likewise, evidence to differentiate birds from the Batanes and the Babuyanes (Manuel, 1936) will exclude those islands from the range of the typical subspecies.

LEUCOTRERON LECLANCHERI PALAWANA Hachisuka.

Ptilopus leclancheri EVERETT, Proc. Zool. Soc. London (1889) 225.

Leucotreron leclancheri McGREGOR and WORCESTER, Hand-list Birds Philip. Is. (1906) 10.

Leucotreron leclancheri palawana HACHISUKA, Birds Philip. Is. 1 pt. 2 (1932) 187.

Palawan.

No specimen was examined for this study.

LEUCOTRERON LECLANCHERI LONGIALIS Manuel.

Leucotreron leclancheri McGREGOR, Bull. Philip. Mus. No. 4 (1904) 6, 9; Philip. Journ. Sci. § A 2 (1907) 338, 345.

Leucotreron leclancheri leclancheri HACHISUKA, Birds Philip. Is. 1 (1932) 186–187.

Leucotreron leclancheri longialis MANUEL, Philip. Journ. Sci. 59 (1936) 307.

The Batanes and Babuyanes, of northern Philippines.

Specimens from Calayan, Camiguin, and Batan were examined.

Measurements of Leucotreron leclancheri longialis Manuel based on two males and one female.

	Male. mm.	Male. mm.	Female. mm.
Wing	160	161	164
Tail	119	121	118
Culmen	[a] 15	16	18
Tarsus	22	20	25
Middle toe and claw	31.5	31	35

[a] Tip of culmen broken.

Distinctly longer wings and tail have been used primarily for separating this subspecies from typical *L. l. leclancheri.* It may be noted that after determining the species of the bird from Batan, McGregor wrote on the label, "Large for this species" (*Leucotreron lechancheri*).

Genus NEOLEUCOTRERON McGregor, 1918

First primary slightly and gradually attenuated near end. Barbules of outer webs of most secondaries decomposed near edge and distinctly colored; some decomposed barbules lengthened, producing an irregular overgrowth in contour of outer web. Habitat, the mountains of Luzon and Polillo.

Two species are known.

Key to the species of Neoleucotreron.

a^1. Tail, 135 mm or longer; center of breast bright orange-vermilion. *N. marchei.*

a^2. Tail, 125 mm or shorter; breast greenish gray .... *N. merrilli.*

NEOLEUCOTRERON MARCHEI (Oustalet).

Ptilopus (Rhamphiculus) marchei OUSTALET, Le Naturaliste (1880) 324–325.

Leucotreron marchei MCGREGOR and WORCESTER, Hand-list Birds Philip. Is. (1906) 10.

Neoleucotreron marchei HACHISUKA, Birds Philip. Is. 1 (1932) 189–190.

Luzon.

Specimens from Mount Tabuan, Cagayan Province; Polis Mountains, Mountain Province; and Mount Casiguran, Tayabas Province, Luzon, were examined.

Measurements of Neoleucotreron marchei (Oustalet) based on two males and three females.

	Extremes. mm.	Mean. mm.
Wing	173.0–188	179.9
Tail	145.0–153	146.0
Culmen	16.0– 17	16.3
Tarsus	27.0– 29	27.9
Middle toe and claw	34.5– 37	35.7

Top of head, cheeks, and sides of throat dull crimson; a large patch on breast orange blending into vermilion-red. Mantle, back, and greater part of wings dusky black. Lower back and rest of wings with a greenish sheen.

NEOLEUCOTRERON MERRILLI MERRILLI (McGregor).

Leucotreron merrilli McGREGOR, Philip. Journ. Sci. § D **11** (1916) 269–271.

Neoleucotreron merrilli HACHISUKA, Cont. Birds Philip. No. 2 (1930) 148.

Neoleucotreron merrilli merrilli MANUEL, Philip. Journ. Sci. **59** (1936) 307.

Mountains of eastern and southern Luzon and Polillo.

Specimens from the Sierra Madre Mountain near Tanay, Rizal Province; and near Paete, Laguna Province, both in Luzon, and from Polillo were examined.

Measurements of Neoleucotreron merrilli merrilli (McGregor) based on three males and two females.

	Extremes. mm.	Mean. mm.
Wing	161–167	163.2
Tail	117–118	117.4
Culmen	14– 15	14.6
Tarsus	23– 27	24.4
Middle toe and claw	33– 34	33.4

Forehead, crown, and sides of head and throat gull gray tinged with green on occiput. Lower breast and abdomen buffish white separated from greenish gray of upper breast by a narrow dark green band that describes an arc in the pectoral region.

NEOLEUCOTRERON MERRILLI FAUSTINOI Manuel.

Neoleucotreron merrilli faustinoi MANUEL, Philip. Journ. Sci. **59** (1936) 307.

Mount Tabuan, Cagayan Province, Luzon. Two males examined. Wing, 168 mm, 168; tail, 118, 121.5; culmen, 16, 15; tarsus, 26.5, 25.5; middle toe and claw, 39, 36.

A patch of van dyke red on crown distinguishes this race from *N. m. merrilli.*

Although the two subspecies of *Neoleucotreron merrilli* are mountain forms, the habitat of *N. m. faustinoi* is in altitude higher than that of *N. m. merrilli.*

PTILINOPUS TEMMINCKII (Des Murs and Prevost).

Kurukuru temminckii PREVOST and DES MURS, Voy. Venus. V. Zool. (1855) 234.

Ptilopus formosus GUILLEMARD, Proc. Zool. Soc. (1885) 269.

Lamprotreron temminckii MCGREGOR and WORCESTER, Hand-list Birds Philip. Is. (1906) 11.

Ptilinopus temminckii HACHISUKA, Birds Philip. Is. 1 pt. 2 (1932) 191.

Celebes and Sulu.

One male and one female from Celebes, but no Philippine specimens were examined.

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LIFE HISTORIES OF SOME COMMON BIRDS IN THE VICINITY OF NOVALICHES RIZAL PROVINCE, LUZON, I

THE LARGE-NOSED SHRIKE, LANIUS SCHACH NASUTUS (SCOPOLI)

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ONE PLATE

INTRODUCTION

The large-nosed shrike, *Lanius schach nasutus* (Scopoli), is commonly met in Philippine fields and meadows. It is known by different names, as "pakiskis," "tarat San Diego," "tarat mamumugot" (Tagalog provinces); "verdugo," "mamumungot" (Cebu); and "palal" (Ilocano provinces).

The entire top and sides of the head of the adult, as well as the sides and back of the neck, are black. The mantle is light gray shading into ocherous-buff on the scapulars, back, rump, and tail coverts. The underparts are white for the most part, although some traces of ocherous-buff are seen coming from the sides. The sides and flanks are ocherous-buff. The crissum is light buff. The thighs are white. The wings and tail are black; the inner webs of the wing quills are edged with white. The third to the tenth primaries [1] show a small white spot near the base of the outer webs, appearing as a distinct white spot when the wing is folded. The inner secondaries have pale buff edges and tips, changing to white in some specimens. The wing, the first alular quill, and the first and second primaries have white edges. The rectrices have narrow pale buff or white tips with the two outermost pairs with pale buff or white margins. All the rectrices have pale buff fringes at the base. The iris is brown. The bill, legs, and nails are black. Ten males average: Length, 238.8 mm; wing, 88.7; tail, 125.8; cul-

[1] McGregor, R. C., A Manual of Philippine Birds, 595, gives "fifth to eighth."

men, 17.7; tarsus, 25.5; middle toe with claw, 23. Seven females average: Length, 224.5 mm; wing, 88; tail, 121.2; culmen, 17; tarsus, 25.3; middle toe with claw, 22.7.

There is no marked sex dimorphism in the adult, although in the male the blackness of the top of the head is more intense. Also, during the nesting season, the male looks more groomed than the female, who neglects the proper care of the plumage during that period.

The young, when ready for flight, differs rather markedly from the adult in the following characteristic features: The entire top of the head, hind neck, and sides of the neck are finely vermiculated with buff and brownish black; the individual feathers are brownish black, edged with buff. The lores and a strip below the eye to the auriculars are brownish black. A broad pale buff band is present above the eye. The mantle is heavily barred with buff and brownish black, with the individual feathers exhibiting gray bases, ocherous-buff tips, and very narrow, brownish black, subterminal bars. The back, rump, and tail coverts are ocherous-buff ranging to light chestnut, with narrow, brownish black, subterminal bars on the individual feathers. The white of the chin and throat gradually changes into buff on the breast, and shades into pale buff on the abdomen. The buffy sides and flanks show faint, narrow, brownish black, subterminal bars on the individual feathers. The crissum is buff; the thighs pale buff. The wings and tail are brownish black, the inner webs of the wing quills with white edges. The third to the tenth primaries show a small pale buff spot near the base of the outer webs, appearing as a distinct spot when the wing is folded. The inner secondaries have ocherous-buff edges and tips, ranging to light chestnut. The wing, the first alular quill, and the first and second primaries have pale buff edges. The primary coverts have white tips; the greater and middle coverts have buff edges and tips. The rectrices have buff edges and tips, the two outermost pairs are buff for the most part, clearest on the outer webs of the outermost pair. All the rectrices have buff fringes at the base. The iris is brown. The bill is yellowish black with bright yellow edges to the mandibles. The gape and the inner lining of the buccal cavity are bright yellow. The legs and nails are horn-colored. The tail is rather short, typically, about 30 mm long.

The large-nosed shrike is, according to McGregor (1909), widespread in Luzon and in most of the islands of the Archipelago.

The present studies carried on in Novaliches, Rizal Province, Luzon, have been made in order to bring to light pertinent facts relative to the breeding of the species, whose life history, like that of most Philippine birds, is practically unknown. Observations were carried on with the aid of field glasses (8x).

HAUNTS AND HABITS

Observations were made in an area of approximately 8 square kilometers immediately adjacent to the Novaliches water reservation.

The site is open rolling country, consisting mainly of grassy areas with irregular patches of bush and tall-tree growth along the small creeks, which usually dry up during the warm months. Here and there are cultivated areas planted to various crops during the different seasons of the year. A plantation of mango, *Mangifera indica* Linn.,[2] is included in the area under observation. The majority of the trees are of medium growth and reclining on the ground, having fallen down during a typhoon. Madre cacao, *Gliricidia sepium* (Jacq.) Steud., is the commonest hedge plant around the cultivated areas. The district is sparsely peopled.

The large-nosed shrike frequents open country, preferring a grass-and-madre-cacao community as described above. It frequently perches on the top of a fence post, a bush, or a small tree, from where it keeps a lookout for insects in the grass below. Whitehead (1899), writing on the habits of this species, noted the same remarkable fact. From time to time it swoops down on the insects, catching them on the wing, sometimes alighting on the ground and staying there for some time, hopping after the intended prey until it is able to catch and kill it with the strong hooked bill. The victim is firmly grasped in the powerful bill of the shrike and taken to the nearest favorable perch where it is consumed.

The bird is noisy. When excited, it gives forth a harsh note closely resembling that of the gray-headed shrike, *Lanius cristatus lucionensis* Linnæus, which frequents the same locality. The commonest note approaches the syllables "keek-keek-keek-keek-etc.," repeated several times in succession. A casual observer will easily mistake the note of this species for that of the gray-headed shrike. However, the note of the large-nosed shrike has a much more intense degree of harshness.

[2] Mr. Edilberto Karganilla, of the National Museum Division, Bureau of Science, identified the plants mentioned in this paper.

The notes of the species are not by any means always the characteristic harsh shrieks. The bird is also quite a notable singer. Perching on a favorite limb or bush top, it sometimes bursts into song, weaving into its melody the notes of different birds. The following interesting observation has been noted in this connection:

May 20.—A bird, perched on top of a mango tree, began to sing. It was a very nice melody consisting of a mixture of call notes of different birds. It trilled the sweet high note of the yellow-breasted sunbird, *Leptocoma jugularis jugularis* (Linnæus), then changed into the soft call of the dominico, *Copsychus mindanensis* (Boddaert). Then, it launched abruptly into the harsh note of the black-and-white fantail, *Rhipidura javanica nigritorquis* Vigors, and suddenly switched into the soft modulated tones of the pied lalage, *Lalage nigra schisticeps* Neumann. It continued singing, for the composition was quite a long melody, and woven further into its song were the notes of the golden-headed cisticola, *Cisticola exilis rustica* Wallace; pied chat, *Saxicola caprata caprata* (Linnæus); white-collard kingfisher, *Sauropatis chloris collaris* (Boddaert); guava bulbul, *Pycnonotus goiavier goiavier* (Scopoli); black-naped flycatcher, *Hypothymis azurea azurea* (Boddaert); Philippine bulbul, *Iole gularis* (Pucheran); Derby's tailorbird, *Orthotomus derbianus* Moore; gray-backed coleto, *Sarcops calvus calvus* (Linnæus); striated marsh warbler, *Megalurus forbesi* Bangs; Philippine rail, *Rallus torquatus torquatus* (Linnæus); and Philippine oriole, *Oriolus chinensis chinensis* Linn. It even attempted to imitate the call note of the island painted quail, *Excalfactoria chinensis lineata* (Scopoli)! I was impressed by its excellent ability to mimic the notes of other birds and expected it to continue weaving into its song notes of other species, when suddenly it changed into the "tweet-tweet-etc." of a helpless nestling. A casual observer could easily mistake it for one. I approached it and immediately it reverted to the harsh note of the species, "keoo-keoo, keoo-keoo", "cheek-keek, cheek-keek, cheek-keek-keek-keek-etc." Then, "keek-keek-keek-keek-etc."

Both sexes have been observed to sing this song during the latter part of May and throughout the other months of the year in which the species is not burdened with nesting activities.

The bird has the characteristic pugnacity of the shrike group. It exhibits this trait in extreme degree during the nesting season, the parents allowing no bird, large or small, to pass the nesting site without chasing it. They fight with birds of their own as well as of other species.

The species nests rather abundantly in the vicinity under observation during March, April, May, and June. The breeding season begins as early as March and continues throughout the summer months. It reaches its height in April and May. The latest record for eggs of the species was June 11, when a nest with one egg was found.

BREEDING HABITS

COURTSHIP

There is a lot of noise and fighting connected with the courting activities of the species. Pugnacity is clearly manifest at this stage, especially on the part of the male. Two or more males often compete for the favor of one female. One can always tell that the species is in the vicinity by the noise that the birds produce. One male sets up a chase for the female, and very soon the other male or males follow. The chase is on, from bush to bush, then around and ultimately back to the original perch. Throughout the whole activity both sexes keep on filling the air with their harsh shrieks. Now, the female is left alone; the males chase each other and fight savagely, at the same time emitting harsh shrieks. One of them later leaves the vicinity of the female. The other then approaches the female on her perch with a grasshopper, a mantid, a long-horned locust, a beetle, or a cricket. The female, after awhile, accepts the gift. The male has still a lot of trouble ahead because sooner or latter the rival male, which he had chased away, returns to the scene to renew the rivalry. The fight between the males is resumed, and this time the other one may have the advantage, in which case the beaten party has to retire from the scene.

The whole procedure is repeated over and over and in different places wherever the female goes. At intervals the birds feed peacefully, but any sign of activity from any one in which the female is involved, always means a resumption of the battle. This happens repeatedly until about the third day, when the female usually begins to show a preference for one male in many little ways. Very often the male who usually comes out victorious in the fighting is the one preferred. Ultimately the rival male ceases to go along.

The male and female search for food together. Usually they do not go far from the scene of the courting activities. In the top of some bush or tree they can usually be seen perching not far from each other. From there they carry on the feeding activities. Throughout the procedure they move from place to place but not far away. Very likely the couple has been determining the possibility and advisability of each place visited, as a nesting site. It may be several days before the birds agree to stay in a place, and by that time they must have visited many places in the immediate vicinity.

The observer can tell when a couple has decided to stay in a site. The male and female stay in the chosen place and in-

clude an area of about 50 meters' radius as their territory. No bird of the same or other species can pass through this territory without being chased or challenged by either parent. It seems strange, but the smaller species are left alone even though they feed in the territory patrolled by a couple. Thus, the yellow-breasted sunbird, *Leptocoma jugularis jugularis* (Linnæus); golden-headed cisticola, *Cisticola exilis rustica* Wallace; pied chat, *Saxicola caprata caprata* (Linnæus); and Meyen's silvereye, *Zosterops meyeni meyeni* Bonaparte were left alone to pursue their various daily activities in a territory of a pair of large-nosed shrikes which was under close observation. On the other hand, the guava bulbul, *Pycnonotus goiavier goiavier* (Scopoli); Philippine bulbul, *Iole gularis* (Pucheran); striated marsh warbler, *Megalurus palustris forbesi* Bangs; Philippine oriole, *Oriolus chinensis chinensis* Linnæus; barred ground dove, *Geopelia striata* (Linnæus); and Philippine crow, *Corvus coronoides philippinus* Bonaparte were chased away from the territory by either one or both owners.

For several days the couple continues to stay and feed in the territory which it has chosen. Led by the female the two birds keep on transferring their perch from one tree to another within the territory.

At intervals between feedings the male from a perch swoops down on the female near-by, and together both birds fall fluttering and shrieking only to separate and return to their former perches when nearing the ground. This act is repeated from time to time, and no doubt copulation takes place during this period.

As soon as the female has found the right place, nest-building activities begin.

NEST AND NESTING

The nest is typically a fairly substantial cup with rather thick slovenly sides of dried grass stems and leaves, lined inside with fine grass inflorescence stalks and roots. It is moderately compact in structure. On the whole the species is not very careful in trimming the external parts of the nest. Not infrequently the grass stems and leaves project from the sides in a slovenly fashion so as to give one the impression that a pile of dead or dying grass stems and leaves has been dumped on a fork or broad cut end of a stem or branch.

The nest is placed in a variety of sites offering the desired strong support, but on the whole leafy and low trees in the open

or along hedges are preferred. In the majority of nests studied the broad cut ends of branches formed the bottom support, and the small twigs at the sides, the side support. Sometimes a natural forking of the main stem is utilized as a safe place. In all cases there is a thick growth of leaves over and around the nest so that a casual observer will not easily find it. Of twenty-eight fresh nests studied fifteen were found in madre cacao trees, ten in mango trees, one in a young shrub, *Semecarpus cuneiformis* Blco., and two in "baga-babui," *Gmelina philippensis* Cham. Of eighteen old nests observed eleven were found in madre-cacao and seven in mango trees, which the species seems to prefer for nesting sites in the area under observation. The following notes illustrate the nature of the nesting sites:

May 2.—A large-nosed shrike nest at the broad cut end of a trunk of madre cacao planted as hedge. The growing twigs at the tip form a very convenient support for the sides. The heavy growth of leaves forms a canopy over the nest, shielding it from the sun's heat and the rain, at the same time hiding it from enemies. About 1.5 meters from the ground.

Nest in another madre-cacao tree:

May 7.—A large-nosed shrike nest in fork of madre-cacao tree planted as hedge. Well located, each of the forked branches about 6 cm in diameter. A natural hollow between provides a nice and safe place for the nest. The newly growing leaves form an effective cover from enemies, heat, and rain. Two to 2.5 meters from the ground.

Nest in a mango tree:

April 22.—A nest with four eggs in a wind-blown mango tree. Well placed on a branch about 6 cm in diameter, and supporting the sides are smaller twigs with luxuriantly growing leaves. Cleverly placed among the foliage so that it was rather hard to discover were it not for the strange behavior of the mother bird. About 1 meter from the ground.

Nest in another mango tree:

May 6.—A large-nosed shrike nest at the cut end of a mango branch. Tree has been raised and pruned after having fallen during a typhoon. Well hidden among the newly growing leaves congregated at the tips of the cut branches. Cannot be easily detected. About 3 meters from the ground.

The nest is not placed very far from the ground. Of the forty-six nests studied, the height ranged from 0.75 to 3 meters, with an average of 1.7 meters.

Nest building is always associated with utmost industry on the part of both sexes. Although the male seems to do a larger share, the two birds work together in collecting the building

materials. The female does the major part of the actual weaving. This does not mean, however, that each sex limits itself to the particular phase of the work which it usually does. The male, after fetching a grass stem, attempts to weave it into the structure of the nest, but his work is subject to the improving touches of the female. She may remove the material from one place and weave it elsewhere or she may leave it as it is. The female fetches building materials and weaves them into the nest.

The building is a gradual process. The bottom foundations are first laid on the selected site. Not infrequently the new nest is built upon an old one or very near it. In this case the new materials are laid on top of the old nest, the latter serving as a bottom support. When the foundation has been laid, the side structure is woven. The materials, usually consisting of long grass stems and fibers, are cleverly interwoven. A single stem with some of the leaves on may be woven in on one side, coiled around, then to the bottom and out to the other side. In this way the materials at the sides of the nest are strongly interwoven with each other and with the materials at the bottom. A cup-shaped cavity is left at the center.

At first the nest looks unkempt, with the grass ends sticking out from the outside and the leaves coming out from all places. The materials forming the sides are grass stems, sometimes as long as 120 cm. Most of the stems make several coils around the nest, thereby making the structure much stronger than if shorter pieces were used. Next, a layer of grass leaves, grass-leaf bases and sheaths, thin bark of bushes, plant fibers, plant down, and tendrils are interwoven at the bottom of the cavity. This layer forms a mattress over the projecting leaves, branches, and other roughness at the bottom. The birds place the inner layer as the finishing touches to the nest. In this layer only fine materials are used, among the most important of which are fine grass stalks and inflorescences, fibers from grass-leaf bases and sheaths, fine grass roots, fibrous weed bark, and the fine stems of grasses. These materials are carefully coiled around so as to form a cozy lining. The birds require from four to seven days continuous work to finish the nest.

In the outer layer of the nest the following may be used: Stems and leaves of *Paspalum conjugatum* Berg. and of *Cynodon dactylon* (Linn.) Pers.; leaf bases, leaf sheaths, stalks, and inflorescences of *Imperata cylindrica* (Linn.) Beauv. and of *Oryza sativa* Linn.; stalks and inflorescences of *Cyperus rotundus*

Linn.; leaves of *Mangifera indica* Linn.; and fine stems of *Hyptis suaveolens* Poir.

In the inner lining the following may be used: Stalks and inflorescences of *Andropogon aciculatus* Retz., of *Andropogon nitidus* (Vahl) Kunth., and of *Paspalum conjugatum* Berg.; roots, stalks, and inflorescences of *Cynodon dactylon* (Linn.) Pers.; and fibers from leaf bases and sheaths of *Imperata cylindrica* (Linn.) Beauv. and of *Oryza sativa* Linn. Incorporated in the structure of the sides are fine stems of unidentified creepers, hemp strings, and cotton threads.

Measurements of forty-six nests of the species gave the ranges as 80 to 90 mm inside diameter, 115 to 135 mm outside diameter, 50 to 65 mm inside depth, and 95 to 121 mm outside depth.

Egg-laying is begun as soon as the nest is ready. The female remains in the vicinity of the nest and feeds near-by. This is much more noticeable after the first egg has been laid. The egg is usually laid during the first half of the day.

The full complement is normally four, although clutches of three eggs are not uncommon. Of twenty-five nests studied twenty-one, or 84 per cent, contained the full complement of four, and four nests, or 16 per cent, contained three. There is an interval of about twenty-four hours between layings.

EGGS

The egg is broad, blunt, and oval, with one end slightly more pointed than the other. There is very little variation among the eggs. The shell is fine in texture and usually dull. In only few specimens is there an indication of a very faint gloss. The ground color is pure white in newly laid eggs, but greenish or creamy white in old eggs. The three eggs originally described by Oates and Reid (1905) must have been old specimens. In nests in which the full complement has not been laid, the newest egg could be distinguished easily from the eggs laid a day or two previously. The egg is spotted and blotched, especially around the broader end, with rusty or reddish brown with undermarkings of pale lavender, changing with age to lilac in some specimens. There is great variation in the density of the spots and blotches; in some it is very slight and in others, quite heavy. In two specimens examined the blotches tended to form a cap at the broader end.

The eggs vary only slightly in size. Measurements of 96 eggs give the following dimensions: Range in length, 21 to 23.5 mm;

mean, 22.5; breadth, 16 to 18.2 mm; mean, 17.1 mm; minimum size of eggs measured, 21 by 16 mm; maximum size of eggs measured, 23.5 by 17.7 mm and 23 by 18.2 mm; average measurements of 96 eggs, 22.5 by 17.1 mm.

INCUBATION

Of the successful nests studied the eggs were hatched thirteen to sixteen days after the full complement had been laid.

The female stays close to the nest immediately after the completion of the clutch. She feeds in a place close to the nest. The male often stays on a perch near-by and performs the duties of a patrol and a sentry. Off he goes on the chase, shrieking wildly as he flies in order to drive away the daring intruder, be this a bulbul or a fellow large-nosed shrike who dares invade the nesting vicinity. He gives the warning shrieks at the approach of any big creature that is beyond his power to chase away. Upon hearing the warning notes of the male, off goes the female to aid him. The couple, then, proceeds to lead the intruder away from the nesting site by various antics, which are very interesting to observe.

The female begins sitting immediately after the full complement is laid, although the serious business of incubation really begins two to three days after the last egg is laid. During this period the female sits day and night. Observations made at night on several nests showed that prior to this time the female does not sit at night, although both parents have been flushed from the nest tree or very near it. From this time until the eggs are hatched, the female sits very close, rarely leaving the nest unless disturbed. The male brings her the insect food that she needs. Starting from the seventh or eighth day of incubation, even in the presence of a disturbing influence, the female is reluctant to leave her eggs, unless she is approached dangerously near. Only the female does the incubating.

Normally, unless disturbed, the full complement hatches. However, when tampered with, taken from the nest or held in the hand, the eggs do not hatch. Of fourteen nests containing full sets, two nests did not give 100 per cent hatching. In one nest the writer held one egg to the light and in the other, he held two of four eggs when measuring them. In these two nests alone were failures in hatching observed. In the twelve other nests the percentage of hatching was 100.

YOUNG

Description of nestlings.—The nestlings of different ages present a variety of characteristic features which change gradually as they grow older.

First day:
- Nestlings naked, tiny and helpless.
- Skin semitransparent and very red.
- Eyes closed but dimly visible through skin.
- Heads seemingly too big for the tiny bodies.
- Movements hardly discernible.

Second day:
- Size increased to about twice the original.
- Skin becomes dark and begins to thicken.
- Movements more discernible.

Fourth day:
- Size increased four times the original.
- Skin acquired fully a dark color in the pterylæ.
- Eyes open and very tiny.
- Wings with erupting bristlelike feathers.

Sixth day:
- Size continues to increase.
- Whole body appears bristly due to erupting feathers.

Eighth day:
- Size continues to increase.
- Bodies clothed with feathers although incompletely.
- Wing feathers longest and most developed.
- Tail feathers begin to develop as a tuft on the uropygium.
- Eyes appear normal in size.
- Heads more in proportion to body size.

Tenth day:
- Size continues to increase.
- Plumage more complete although apteria are still visible in some places.
- Wing feathers open along entire exposed length.
- Tail feathers open but very short.
- More conscious protective reactions.

Twelfth day:
- Size about that of adult.
- Plumage more complete but apteria on ventral surface still visible.
- Longest tail feathers about 10 mm in length.
- Yellow gape and buccal lining very striking.

Fourteenth day:
- Plumage more complete but apteria on ventral surface still visible in some few places.
- Longest tail feathers about 15 mm in length.
- More conscious protective reactions.

Sixteenth day:

Young capable of flight although not long sustained.

Plumage complete.

Longest tail feathers 20 mm in length.

Capable of taking care of themselves by more purposive protective reactions.

The young are ready to leave the nest in seventeen to nineteen days after hatching. They may take flight after the fourteenth day, especially when danger threatens. In such a case, however, the young have the minimum chance to survive as they are not yet fully equipped. Observations on five nests gave the range as seventeen to nineteen days before the young were fully able to leave the nest voluntarily. In two nests the young left in seventeen days after hatching; in two others they left in eighteen days, and in one nest in nineteen days.

Care of young.—Immediately after the hatching of the eggs, the parents begin to work harder. During the first six days the mother stays very often in the nest, perhaps in order to shelter the nestlings who, up to this time, are devoid of feathers. The responsibility of procuring food for the nestlings during this time rests mainly on the male, although the female also goes out at times and procures food for them near-by. As soon as the young have grown enough feathers, the search for food is performed by both parents. They take turns in going out, being always careful that one of them is left in or near the nest. During this stage the territorial rights are very well upheld. The parents are always ready to chase any other large-nosed shrike that may happen to hunt for food within the bounds of the territory. As a result much fighting takes place, and in no other period is the species more quarrelsome, more pugnacious, or more noisy. Every intruder is heralded by the harsh warning notes of the parent that first happens to notice the approaching danger.

The following notes illustrate the behavior of the parents when the nestlings are actually intruded upon, in the nest. In this case the nest was in a pruned mango tree about 3 meters from the ground and the nestlings were two days old.

May 26.—The female stayed in the nest until approached dangerously near when she flew to a near-by dead and storm-blown mango tree. The male immediately came and perched near the female close to the nest tree. He kept on protesting. The female was very vehement in her protests. She kept on having her feathers fluffed up and ruffled so she would look very sickly and weak. Then with the head pointed down, she commenced to fall from the topmost branches of the dead tree, vertically from limb

to limb, each drop about 30 cm from the previous perch. She effectively simulated a very weak bird and at first sight an observer would think she was really falling from sheer weakness. The male followed suit and for about five minutes both birds kept it up, beginning from the topmost branches and falling until within about 60 cm of the ground.

Upon coming down from the nest tree I observed the male flying weakly away to a near-by tree about 3 meters farther. The female soon followed, fluttering weakly away. She made a detour and perched on the nest tree but on the other side of the nest. The male kept on fluttering weakly from tree to tree until I was led about 100 meters away from the nest tree, when with rapid beats of the wings he made a detour and perched on top of a mango tree, at the same time uttering harsh complaining notes. When left alone at last, he continued on his hunt for food.

The nestlings are always on the alert for the parental warning notes. Immediately upon hearing them they lie low and remain motionless at the bottom of the nest. The same reaction has been observed in all nestlings of different stages.

If caught standing the older nestlings maintain the same position and remain motionless until such time as they deem it wise to move and go back into the nests, there to lie low. In several instances older nestlings were surprised standing on the rim of the nest, among the twigs, with the mouth wide open. The same reaction has been observed in younger nestlings with the eyes already open. In connection with this remarkable phenomenon it is well to note that the open mouth presents a frightening spectacle because of its bright yellow interior and borders. The sight can easily frighten nervous intruders away, and in this way helps in the preservation of the individual.

Upon leaving the nest the young birds are led by the parents to some particular bush or tree, often in the nesting territory, which the older birds, perhaps, consider a safe shelter for them. The parents continue procuring food for the the young ones, although by this time the young must have begun receiving their instructions from the parents regarding food-getting. When a family is approached closely, the parent birds do a great deal of shrieking. One of them, most likely the male, usually approaches the intruder with initial warning notes resembling the syllables "keoo-keoo-etc.," repeated several times. These are followed by another set of notes resembling the syllables "cheek-keek, cheek-keek, etc.," also repeated several times. The bird then flies to a near-by tree but farther from the young, all the while shrieking wildly. The notes are different, this time resembling the syllables "cheek—keek–keek, etc." These notes are repeated over and over again as long as the intruder is in

the vicinity. The other parent follows later, perhaps after having made sure that the young ones are safely hiding, also making a lot of noise. They keep this up, all the time flying farther and farther away from the hiding place of the young ones. Upon seeing that the danger is past, one of the birds, most likely the female, stops shrieking and flies in a roundabout way, back to the young. The other keeps on scolding, but later follows as soon as everything is well.

The young birds stay close to their parents as much as possible. Upon hearing the warning notes of either parent they proceed to hide themselves in places where they are least likely to be seen. Several young birds were observed to stay in the thick growth of leaves at the ends of the cut branches of a pruned mango tree. They stayed there and remained motionless until all was quiet, and then flew away with the parents to another tree.

The young birds continue to accompany their parents until they are old enough and are fully able to take care of themselves. Young birds with tail feathers about 11 cm long, calculated to be about ten weeks old, have been commonly observed feeding in the company of adult couples, which in all probability were the parents.

PREDATORS

The large-nosed shrike, like other species of birds, is subjected to an immense number of factors that tend to control its number within reasonable limits so as to maintain the normal biological balance. Among the most important of these factors is the presence of predators preying on the eggs, the young, and even the adults of the species.

Twenty-eight nests were under close study throughout the period of observation. In only six nests were nestlings successfully reared until they were able to fly. This means that only 21 per cent of the possible number of sets of nestlings were able to leave the nest unharmed. It does not mean that this number of successful nestlings will remain so until they become adult. Immediately after the young leave the nest, the same dangers confront them and may cut their number to a still lower percentage. Ultimately, only a small fraction of the young hatched reach maturity.

Twenty-six nests of the original twenty-eight under observation contained the full complement of eggs. Two nests were robbed of their contents before the sets were complete. In one nest there were only two eggs when it was robbed; in the other,

only the first egg was ever laid. Eleven nests of the original twenty-six that contained the full complement of eggs were robbed of their eggs, leaving only fifteen nests with eggs to hatch. This leaves only 58 per cent of the original number of sets to be hatched. Eight of the fifteen nests that contained nestlings were robbed of these nestlings at different stages of development, but in all cases still incapable of flight. Thus, only 40 per cent of the sets of eggs hatched lived to the time of flight from the nest. Consequently, the owners of only six nests, or 21 per cent, of the twenty-eight nests studied were successful in rearing the young to the time they were capable of leaving the nest.

Predators that are observed to roam the vicinity are the crow, *Corvus coronoides philippinus* Bonaparte; the monitor lizard, *Varanus salvator* (Laurenti); and the civet cat, *Paradoxurus philippinensis* Jourdan. Perhaps there are still others.

Crows were frequently observed feeding within the area of observation, and they were held mainly responsible for the immense number of missing eggs. In several instances, flocks of ten or twelve were observed alighting in a vicinity. After they were gone, nests in that particular vicinity were frequently found to have been robbed.

Monitor lizards, large and small, have been observed to abound in the vicinity. Many have been shot or procured with dogs. A monitor lizard of medium size was observed to leave a nest tree, and the writer fearing for the safety of the nestlings under study immediately went to the nest. Not a trace of the nestlings was left.

Civet cats have been caught many times by the farmers in the vicinity. In several instances nests observed to contain nestlings late in the afternoon were found to have been robbed of their live contents early the next morning. There is only one probable explanation of this phenomenon; a predator had visited the nests sometime in the evening and deprived them of their contents, possibly even including the brooding mother.

In all likelihood there are other predators roaming around in the area under observation, but the toll exacted by these three creatures is enough to give an idea of the cause of the excessively high rate of mortality in the species.

SUMMARY AND CONCLUSIONS

1. Studies on the breeding habits of the large-nosed shrike, *Lanius schach nasutus* (Scopoli), were made in the vicinity of

Novaliches, Rizal Province, Luzon, within an area of about 8 square kilometers.

2. The species breeds during March, April, May, and June. Nesting reaches its highest in April and May.

3. Courtship is replete with fighting and noise; at no other time is the species more pugnacious, quarrelsome, and noisy.

4. The nests are cup-shaped and made mostly of grass. Stems, leaves, stalks, and inflorescences, mango leaves, and other plant materials are woven into a cup with thick sides. Forty-six nests gave as average measurements, 128 mm outside diameter, 82 mm inside diameter, 57 mm inside depth, and 102 mm outside depth.

5. The nests were frequently found in madre cacao, *Gliricidia sepium* (Jacq.) Steud., and mango trees, *Mangifera indica* Linn. This shrike places the nest preferably in low leafy trees in the open or along hedges.

6. The egg, a broad blunt oval with one end slightly more pointed than the other, possesses a greenish or creamy white ground color with little or no gloss. It is spotted and blotched, especially around the larger end, with rusty or reddish brown, with undermarkings of pale lavender changing to lilac. The average measurements are 22.5 mm by 17.1 mm.

7. The full complement of eggs is normally four, observed in 84 per cent of the nests studied, although sets of three eggs are not rare, represented by 16 per cent of the nests studied.

8. There is an interval of one day between layings, and the eggs are laid during the first half of the day.

9. Incubation takes from thirteen to sixteen days and is performed solely by the female.

10. The young leave the nest in from seventeen to nineteen days after hatching, although at times they may leave as early as the fourteenth day.

11. The young go with the parents even until they have about acquired the adult plumage.

12. Predators, such as crows, *Corvus coronoides philippinus* Bonaparte; monitor lizards, *Varanus salvator* (Laurenti); and civet cats, *Paradoxurus philippinensis* Jourdan, destroy many eggs, nestlings, young birds, and adults.

13. Twenty-eight fresh nests were under close observation. Only six sets of eggs in six nests, of the original twenty-eight, were hatched and reared to the time the young were voluntarily able to leave the nest. Only 21 per cent of the original sets were reared successfully.

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ILLUSTRATION

PLATE 1. Nestling large-nosed shrike, *Lanius schach nasutus* (Scopoli), in the nest.

PLATE 1.

NOTES ON FISHES IN THE ZOÖLOGICAL MUSEUM OF STANFORD UNIVERSITY, V

NEW OR RARE PHILIPPINE FISHES FROM THE HERRE 1933 PHILIPPINE EXPEDITION

By ALBERT W. C. T. HERRE
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TWO PLATES

Continuing the account of new or rare fishes in the Stanford University Museum collected by me during the past five years, I herewith present seven new species, one new genus, and distributional notes upon a number of rare species, most of them hitherto unknown from the Philippines. Part of November and most of December, 1933, were spent in the Philippines. Stops were made at Davao, Zamboanga, Dumaguete, Cebu, Iloilo, and Manila in the order named. No intensive collecting was done except at Dumaguete, Bais, Oriental Negros, and at Opon, Mactan Island.

The fact that new and distinctive species were obtained at Dumaguete, where I have been working the tide pools at every opportunity for the past sixteen years, speaks volumes for the incredible richness and variety of Philippine fish life. There is no doubt that intensive collecting would yield equally good returns at many points along the coasts of Luzon. Taking a blenny at Paraoir, La Union Province, that was only known from specimens collected in Java nearly eighty years ago, is sufficient proof of my statement.

Evidence is constantly accumulating that many shore fishes as yet known only from the Philippines are widely distributed in the China Sea; if not already known there, they are to be looked for at Hainan, along the coast of Indo-China, and on the shores of the Malay Peninsula and Singapore. In the same way, many more fishes hitherto known only from the Moluccas, Sunda Islands, and even from the far distant Hawaiian Islands, will eventually be found in the Philippines.

In spite of the great number of gobies already reported from the Philippines, the evidence points to the conclusion that many more gobies are to be discovered in Philippine waters. This

is particularly true of certain regions; large collections should be made in brackish waters, in estuaries, and on mud flats exposed at low tide, as well as in tide pools. Nothing has been done as yet towards collecting gobies below low tide, in water from one to eight meters deep. A rich harvest awaits anyone who uses a diving helmet for collecting gobies. Much of what has just been said applies equally to the blennies, which have been but little collected. They are very difficult to catch, but patience and skill will get them.

Other groups meriting special attention are the sharks and rays, catfishes, eels, Sparidæ, and Sciænidæ, all of them of much commercial importance and very incompletely known from Philippine waters.

Types of new species are in the Stanford University Museum, and paratypes in the Bureau of Science collection where material allows.

OPHICHTHYIDÆ

CÆCULA PHILIPPINENSIS sp. nov. Plate 1, fig. 1.

The depth is 38.4, the head 12.166 times in the length; the head is 5.6 in the trunk, which is more than 2.5 times in the total; the tail is longer than the head and trunk together, their length being about 47 per cent of the tail. The eye is 17.3 times in the head, 3 in the very slender, sharp-pointed snout, which is nearly 5.8 times in the head; the gape is 4⅓ times in the head; the gill openings are unequal in size and position, the right one being anterior to and about 3 times as large as the posterior left one. The dorsal origin is almost over the left gill openings, the distance between being 13 times in the head. The fins are low, of equal height or the anal a trifle higher, their height about 6.5 times in the head. There are vomerine teeth in a single row, smaller than the single row of teeth in the jaws; on the intermaxillary plate are 3 larger teeth.

Color in alcohol uniform brown above, merging into violaceous brown beneath.

The type and only specimen, 365 mm long, was taken at Dumaguete, Negros.

SYNGNATHIDÆ

SYNGNATHUS MARTINI sp. nov. Plate 1, fig. 2.

Dorsal 37; pectoral 13; caudal 10; anal 4; rings 19+39; subdorsal rings 5+5.

The depth is 28 in the length, 3⅓ times in the head, and 8 in the trunk, equal to the caudal; in the figure the artist has in-

cluded the open and expanded brood pouch, thus increasing the apparent depth beyond its true ratio; the head is 8.4 times in the length, 2.4 in the trunk, and 5 in the tail; the trunk is a little more than twice in the tail and the head and trunk together are 1.47 times in the tail; the dorsal base is a little longer than the head. The eye is 6.66 times in the head, twice in the caudal; the snout twice in the head. The egg pouch is on the last trunk and 17 tail rings, and is $^{15}/_{16}$ of the trunk length or 2.2 times in the tail; it is partly filled with embryos, and is much dilated.

Body very elongate, trunk heptagonal, tail 4-sided except along the egg pouch where it is hexagonal; the smooth shields are transversely striated; the superior cristæ of trunk and tail are discontinuous, the inferior cristæ continuous; the lateral median trunk cristæ end at the hind edge of the last trunk ring, the superior cristæ of the tail beginning above, in middle of the last trunk ring.

The snout has a smooth sharp median keel reaching to the concave interorbital; a pair of low smooth lateral ridges extend to the prominent orbital ridges and slightly beyond. At the hind end of the interorbital is a smooth median ridge, followed by another smooth median ridge on the nape, terminating above the pectoral base. The operculum has a very small straight keel on its anterior fourth, with very many minute radiating reticulating ridges.

The color in alcohol is brown, with darker brown crossbands.

Described from the type and only specimen, 168 mm long, from Manila Bay. Though close to *S. acus,* the dorsal position is very different. It is still closer to *S. yoshi,* from which it differs in several particulars.

I take pleasure in naming it for Mr. Claro Martin, of the Philippine Fish and Game Administration, who is an earnest worker on the Philippine fish fauna.

GOBIIDÆ

VAIMOSA MONTALBANI sp. nov. Plate 1, fig. 3.

Dorsal VI–1, 7; anal I, 6 or 7; there are 6 predorsal scales in males, 7 in females, 7 in a tranverse series, and 24 or 25 in a longitudinal series, plus 1 or 2 on the caudal base.

Males have a stout body with strongly arched back, the depth 3.5 to 3.65, the head 2.75 to 3.3, the caudal 3 to 3.5 times in the length; the eye is in the anterior half of the head, 3.25 to 3.5, the snout 4.5 to 4.66, the maxillary 1.8 to 2.2, the least depth of the caudal peduncle 2.8 times in the head. The elon-

gated and threadlike first dorsal spine extends upon the second dorsal, sometimes reaching its posterior extremity, 2.5 to 4.5 times in the length; the second dorsal and anal rarely extend to the caudal base when depressed, 1.7 to 2 times, the pectoral 1.4 to 1.5 times in the head; the ventrals extend to the anal origin or beyond, 1.3 to 1.4 times in the head.

Females do not have the back elevated, the low first dorsal does not reach the second dorsal when depressed, the ventrals are shorter, and the second dorsal and anal are noticeably lower than in males.

A female 18 mm long has the depth 3.6, the head 2.8, the caudal 3.6 times in the length; the eye is in the anterior half of the head. The snout is 4, the eye 3.2, the maxillary 3.2, the pectoral and ventral each 1.6 times in the head.

In males the large maxillary extends below the posterior part of the eye or beyond, in some almost to the rear angle of the preopercle. In females the mouth is much smaller, the maxillary extending to the eye or beneath its anterior half.

Males are pale yellowish brown in alcohol, with dark brown spots and scales sprinkled over the upper half; there are a dark brown spot at the upper angle of the opercle, 4 dark brown spots in a row along the middle of the side, a large blackish brown spot at the caudal base (often with a pale center), and a row of black spots under the anal and caudal peduncle; behind the pectoral is a dark brown vertical bar, and a similar bar crosses the belly over the anus; the sides of the head are mottled with yellowish and dusky brown; the first dorsal is deep black above and posteriorly, with a dusky basal crossbar and two black spots on the anterior margin, the rest of the fin clear; the soft dorsal and caudal each have two or three dusky brown crossbars; the anal and the ventral membranes are dusky, the pectorals clear.

Females are similarly marked, but are very much paler, their markings nearly disappearing.

Here described from the type, 20 mm long, and 35 paratypes, 14 to 23 mm long, from Lake Naujan, Mindoro.

This little goby is close to *Vaimosa dispar* Peters, but differs markedly in scalation and color markings, and the elongated first dorsal spine. It agrees with *V. dispar* in the large mouth and elongated maxillary of males, and in the males being larger than females.

I take pleasure in naming this goby for Mr. H. R. Montalban, who was my associate in an exploration of Lake Naujan.

CTENOGOBIUS VILLADOLIDI sp. nov. Plate 2, fig. 4.

Dorsal I, 12; anal I, 12 or 13; scales in longitudinal series 27 or 28 plus 1 on the caudal base and 8 in transverse series; predorsal none.

The depth is 6.4 to 6.7, the head 3.4 to 3.5, the caudal 4.14 to 4.4, the pectoral 3.9, the ventral 3.6 to 3.9 times in the length; the eye is 3.9 to 4.1, the snout 5 to 5.5, the maxillary 3.3 to 3.5, the least depth of the caudal peduncle 4.1 to 4.3 times in the head.

The body is slender, elongate, the breadth greater than the depth, wedge-shaped viewed from above, with pointed head, the breadth of the head 1.45 to 1.5 in its length; the prominent dorsolateral eyes project above the dorsal profile, are longer than the steeply descending snout, and meet or nearly meet at their inner margins; the mouth is oblique with projecting lower jaw, the maxillary angle beneath the front margin of the pupil; the teeth are minute, no canines; the tongue is rounded to truncate, the head is entirely naked, without scales above the opercles; the breast is naked, the rest of the body covered with large ctenoid scales of uniform size, their cilia very minute. The first dorsal barely reaches the second dorsal when depressed, both dorsals of the same height, 2.1 to 2.3 in the head; the anal is a little lower, 2.9 to 3 in the head; the slender, round-pointed caudal shorter than the head; the broad, well-developed ventrals extend to or beyond the anal origin.

The color in alcohol is whitish with blackish scale margins on the upper half, some of them on the sides enlarged to form a row of five black spots, the last on the caudal base; the entire head and body are more or less thickly sprinkled with black specks; the first dorsal is sprinkled with black dots and white or clear spots, and in males also has one to three large elongated black spots along the fourth or third, fourth, and fifth spines; the second dorsal is densely sprinkled with black dots, often with a clear margin; the anal has a broad black longitudinal band, the tips of the rays white; the caudal is barred by several rows of black spots, the tip black with a white margin; a black bar on the upper part of the pectoral base, the fin clear or specked with black; the ventrals are black with a broad white margin or may be colorless.

Described from the type, 31 mm long, and 14 paratypes, 17 to 31 mm long, collected from a tide pool near Dumaguete, Oriental Negros.

This species is close to *Ctenogobius nuchipunctatus* but differs in many respects.

I take pleasure in naming it in honor of Dr. Deogracias Villadolid, student of Philippine fishes for many years, to whom I am indebted for much valuable assistance.

SCHISMATOGOBIUS ROXASI sp. nov. Plate 2, fig. 5.

Dorsal VI–I, 9; anal I, 8; no scales.

The depth of the naked, robust, well-rounded body is contained 5 times, the caudal, pectoral, and ventral each 4.4 times in the length. The large, broad, flattened head is 2.75 times in the length, its breadth 1.75 times in its own length. The small eye is 8 times in the head, twice in the bluntly pointed snout; the flat interorbital is 6.4 times in the head; the postorbital region is 1.8 times in the head or one and two-thirds times the eye and snout together. The large mouth is oblique, its angle beneath the front of the pupil, but the maxillary is greatly widened and lengthened and reaches almost to the angle of the preopercle, its length equal to that of the caudal or to the postorbital part of the head, 1.6 times in the head; the tongue is notched; the small teeth are in bands of 5 or 6 rows in both jaws. The dorsals and anal are all low; the first dorsal height is 3.7, the second dorsal 2.46, and the anal height 2.66 times in the head.

The color in alcohol is brown to yellowish brown, mottled with irregular flecks and streaks of blackish, and with three dark brown dorsal crossbands, the first beneath the first dorsal, the second under the middle of the second dorsal, and a third narrower one on the caudal peduncle. Both dorsals, the caudal, and pectorals are crossbarred by rows of black spots; the ventral rays are colorless, but the membranes between are black with a mass of dusky spots; the ventrals are colorless.

Described from the type and only specimen, 44 mm long, from San Jose, Antique Province, Panay. It is close to *Gobiosoma insignum,* but differs in the extraordinary development of the maxillary. From *Schismatogobius* as defined by de Beaufort it differs markedly in the character of the teeth, and I am therefore uncertain as to its exact generic position.

I am pleased to name this in honor of Dr. Hilario A. Roxas, chief of the Philippine Fish and Game Administration, who is devoting his energies to studying the greatest natural food resource of the Philippines, the fishes of the Philippines waters.

MARS HAYDENI sp. nov. Plate 2, fig. 6.

Dorsal VI–I, 12; anal I, 12; about 65 scales in a longitudinal series.

The body is slender, with nearly horizontal dorsal and ventral profiles, the depth 6, the head and rounded caudal each 3.55, the pectoral 4.5, the ventral 5.3 times in the length. The eye is in the anterior half of the head, equal to the convex blunt snout, 4.5 times in the head; the eyes are very close together, their inner margins touching, very high up, dorsolateral; the mouth is oblique, the maxillary extending beneath the anterior part of the pupil, 3 times in the head; the upper jaw has an outer row of enlarged teeth, and behind it a band of four rows of minute teeth; there is a similar band in the lower jaw with an outer row of much larger teeth ending in a small lateral canine on each side; the vomer has two broad teeth; the cheek is margined by sensory papillæ and has two longitudinal rows also, while the opercle has two perpendicular and some marginal rows. A low median ridge extends from the first dorsal to the interorbital. The scales are ctenoid posteriorly, becoming much smaller above the pectoral but not extending forward beyond the hind margin of the opercle, where they are apparently cycloid; the head, pectoral base, and breast naked.

The fins are low, the third dorsal spine 6 times in the length or 1.63 in the head; the penultimate second dorsal ray 2.25 in the head, the anal scarcely as high; the least depth of the caudal peduncle 2.6 in the head; the ventral reaches to the anus, the pectoral a little beyond the ventral tip.

The color in alcohol is pale olive-brown with nine darker crossbands across the back and down the sides, the first two over the head and nape, the next two under the first dorsal, the four following under the second dorsal, and the last on the caudal peduncle; the sides of the head and anterior half of the body are sprinkled with circular black or dark brown dots; the caudal is crossed by several broad dark bands on its basal half, the outer and upper portion barred by rows of black dots; the whitish first dorsal has two longitudinal dark brown bands; the whitish second dorsal has a basal dark band, and two longitudinal rows of elongate black spots on its middle and upper portions; the anal and ventrals are uniformly blackish; the clear pectoral is a little dusky basally.

Described from the type and only specimen, 32 mm long, which I caught on the tide flats at Bais, Oriental Negros. From the

other members of *Mars* this species differs in its fins, poorer development of sensory papillæ and vomerine teeth, and in its occipital ridge.

I take pleasure in naming this species after Dr. J. Ralston Hayden, of the University of Michigan and formerly Vice Governor General of the Philippine Islands, in recognition of his knowledge and appreciation of all phases of Philippine life.

BLENNIIDÆ

SALARIAS FOWLERI sp. nov. Plate 2, fig. 7.

Dorsal XII, 19 or 20; anal II, 20. Minute simple nasal, orbital, and nape tentacles present, or any one or two pairs may be absent; no occipital crest, and no canines.

The depth is 6 to 6.2, the head 4.8 to 5.1, the pectoral 4 to 4.4, the ventral 7.75 to 8 times in the length.

The eye, snout, and least depth of the caudal peduncle each 3 times in the head. The body is elongate compressed, with bluntly rounded head, which is broader than deep; the anterior profile is nearly vertical, the mouth slightly projecting, the maxillary extending beneath the posterior portion of the prominent eye. The dorsal is moderately notched, of nearly uniform height, 2 in the head, the anal 3 times. The dorsal and anal do not extend to the caudal and are free.

The color in alcohol is whitish, with seven brown spots along the middle of the side, each spot containing three or more conspicuous black dots; between the spots are dots and specks, and along the lower side is a row of prominent black dots; rather faint brown dorsal bands composed of minute dots are opposite the lateral spots; the head and upper anterior half are more or less covered with minute brown specks. There are three or four rows of black dots on the dorsal rays, the intervening portions white, the membrane clear; nine or ten black dots are beneath the anal which is clear with a black submarginal band and a white margin; the caudal has four black crossbars.

Described from the type, 31 mm long, and 9 paratypes, 16 to 28 mm long, taken from a tide pool at Dumaguete, Oriental Negros.

I take pleasure in naming this pretty blenny for Henry W. Fowler, who has made notable contributions to our knowledge of Philippine fishes.

ANGUILLIDÆ

ANGUILLA SPENGELI M. Weber.

A number of elvers, 60 to 80 mm in length, seem to be this species. They were taken from a brook at the San Ramon Penal Colony, Zamboanga, Mindanao.

MYRIDÆ

MURÆNICHTHYS SIBOGÆ Weber and de Beaufort.

A specimen of this very rare eel, 102 mm long, was caught at Dumaguete, Negros. It is a small species hitherto known only from the Dutch East Indies. A specimen 103 mm long, taken by the Siboga Expedition, was fully mature.

OPHICHTHYIDÆ

CIRRHIMURÆNA OLIVERI (Seale).

Four young specimens, 70 to 88 mm long, were taken on Pasay Beach, Manila Bay. Previously known only from the type, 380 mm long, from Zamboanga, Mindanao, and a specimen 500 mm long from Tablas.

CLUPEIDÆ

ALOSA PLATYGASTER (Günther).

A specimen 55 mm long, from the southern coast of Tayabas Province, Luzon, agrees with the description by Weber and de Beaufort. New to the Philippines.

MUGILIDÆ

MUGIL STRONGYLOCEPHALUS Richardson.

Two specimens, 102 and 110 mm in length, agree with specimens I collected in Kwangtung Province, China. New to the Philippines, and previously known only from the southern coast of China.

GEMPYLIDÆ

RUVETTUS PRETIOSUS Cocco.

New to the Philippines. Three specimens of the singular oilfish were seen, caught on the Pacific coast of Camarines Norte Province, Luzon. I was able to get but one, 620 mm long. A much larger specimen had been cut up for food, and the third specimen was in such condition as to be useless for scientific purposes.

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This circumtropical deep-sea fish is readily recognized by its large eyes, large mouth filled with sharp teeth, its very rough scales, black color, and oiliness. After several years in alcohol specimens still cover one's hands with oil when handled. Specimens long preserved gradually change to uniform brown, losing their original black color.

The oilfish is the object of a remarkable long-line fishery throughout Polynesia and Melanesia. It reaches a length of at least 3 meters, and is caught off-shore in the open sea at depths of 100 to 800 meters or more. It is taken on dark nights, when there is no moon and the sea is perfectly calm. The flesh is very toothsome, but is very rich in an oil that has an extraordinary and exceedingly rapid purgative effect when eaten.

LEIOGNATHIDÆ

LEIOGNATHUS BREVIROSTRIS (Cuvier and Valenciennes).

New to the Philippines. Five specimens, 66 to 80 mm in length, were dredged from Manila Bay. There are no scales on the breast, and in other respects the specimens agree with Weber and de Beaufort's description.

LEIOGNATHUS LINEOLATUS (Cuvier and Valenciennes).

Two small examples, each 51 mm long, were obtained at Iloilo, Panay. New to the Philippines.

SERRANIDÆ

ANTHIAS HUCHTI Bleeker.

A typical example, 48 mm long, was taken from a Dumaguete, Negros, tide pool. New to the Philippines.

POMADASYIDÆ

Genus LUZONICHTHYS novum

Fowler described and figured a fish which he called *Mirolabrichthys waitei*.[1] The chief characteristic of the genus *Mirolabrichthys* Herre is the proboscislike, fleshy, pointed papilla on the tip of the snout. This flexible pointed tip is entirely lacking in *Mirolabrichthys waitei* Fowler, and it also differs in some other particulars, lacking filaments on the ventrals and having the jaws even. I therefore propose the name *Luzonichthys*, with *Luzonichthys waitei* (Fowler) as its type.

[1] U. S. Nat. Mus. Bull. 100 11 (1931) 228.

LUZONICHTHYS WAITEI (Fowler).

A typical specimen, 47 mm long, was collected at Dumaguete, Negros.

SPARIDÆ

NEMIPTERUS TAMBULOIDES Bleeker.

A specimen from the southern coast of Luzon, 109 mm long, seems to belong here. New to the Philippines.

SCIÆNIDÆ

OTOLITHES ORIENTALIS Seale.

This species is well represented by two specimens from Manila Bay, 94 and 140 mm long. Previously known only from the type, 235 mm long, from Sandakan, British North Borneo.

CIRRHITIDÆ

CIRRHITUS MARMORATUS (Lacépède).

A fine example of this wide-spread Indo-Pacific species, 125 mm long, from the coast of Batangas, Luzon. New to the Philippines.

SCORPÆNIDÆ

MINOUS TRACHYCEPHALUS Bleeker.

An excellent example, 53 mm long, was obtained from Subic Bay, Luzon. Bleeker had but 8 specimens, 49 to 80 mm in length, from the Dutch East Indies. New to the Philippines.

PLATYCEPHALIDÆ

ROGADIUS POLYODON (Bleeker).

A young specimen, 51 mm long, from Batangas Bay, Luzon, belongs here, corresponding in detail to Bleeker's description and figure. New to the Philippines. Bleeker had but 4 specimens, 118 to 180 mm long, from Java, Celebes, Ceram, and Amboina.

ELEOTRIDÆ

HYPSELEOTRIS BIPARTITA Herre.

Hypseleotris bipartita HERRE, Gobies of the Philippines (1927) 39, pl. 3, fig. 1.

A fine adult specimen, 37 mm long, and 25 juvenile examples, from 14 to 20 mm in length, from San Agustin River, a tributary of Lake Naujan, Mindoro. This easily recognized little eleotrid has been collected previously only in Albay Province, Luzon.

PARVIPARMA STRAMINEA Herre.

Parviparma straminea HERRE, Gobies of the Philippines (1927) 82, pl. 6, fig. 2.

This very rare eleotrid, hitherto known only from the type, 65 mm long, from Saug River, southern coast of Cotabato Province, Mindanao, is represented by an elegant specimen, 85 mm long, from Aparri, Luzon.

The depth is 7 times, the head and caudal each 4.7, the pectoral and ventral each 7 times in the length; the width of the head is 1.5 times in its own length. The eye is 9 times in the head and twice in the snout; the interorbital and snout are equal, 3.6 times in the head. The other characters are as given in my original description.

GOBIIDÆ

HERREA PRODUCTA (Herre).

Galera producta HERRE, Gobies of the Philippines (1927) 104, pl. 7, fig. 3.[3]

This unique goby was described from the type and only specimen, 49 mm long, from Puerto Galera, Mindoro. From a Dumaguete tide pool I collected 3 fine examples, 52 to 66 mm in length. They are plumper than the type, which was much shriveled by strong preservative.

The depth is 6.5 to 7.4 times, the caudal 2 to 2.36, the head 4 to 4.7, the pectoral 3, the ventral 5 times in the length. The eye is 4 to 4.33, the snout 4 times in the head; the interorbital is twice in the eye. The second dorsal and anal rays are much elongated posteriorly, 1.5 times as high as the anterior or middle rays, and nearly equal to the head.

The color in alcohol is yellowish, densely sprinkled with dark brown, which becomes a uniform coat above; from the eyes a blackish band extends above the opercles to the pectoral angle and curves up to the dorsal origin to meet its fellow from the other eye; beneath the first dorsal a blackish band extends downward and forward to the abdomen; a similar band extends downward and backward from the middle or posterior part of the second dorsal to the posterior rays of the anal; a vertical blackish band on the caudal base; the caudal is black or blackish, the other fins all crossbarred by many rows of dark brown spots or blotches.

[3] *Herrea* Whitley, Australian Zoölogist 6 (1930) 123, replaces *Galera* Herre, preoccupied for a genus of mammals, see Gray, Contributions, British Museum (1842).

GLADIOGOBIUS ENSIFER Herre.

Gladiogobius ensifer HERRE, Copeia (April, 1933) 23.

By far the best specimen of this unique goby seen was taken on the tide flats at Bais, Oriental Negros. It is the largest one yet collected, its length 40 mm; its proportions do not differ materially from those published. It has a low but conspicuous occipital crest from the eyes to the dorsal origin. The color markings are as given in the original account.

OLIGOLEPIS MOLOANUS (Herre).

Aparrius moloanus HERRE, Gobies of the Philippines (1927) 207, pl. 16, fig. 3.

An example 37 mm long from the mud flats at Opon, Mactan Island, establishes a new Philippine record. Hitherto it has been taken in the Islands only in Iloilo and Antique Provinces, Panay.

Dr. Hugh M. Smith obtained 8 specimens, 55 to 66 mm long, in the estuary of Chantaban River, southeastern Siam. This greatly extends the range of the species and is in line with the recent discovery in Singapore and the Malay Peninsula of other gobies previously known only from the Philippines.

APOCRYPTODON SEALEI Herre.

Apocryptodon sealei HERRE, Gobies of the Philippines, Bur. Sci. Monograph 23 (1927) 278.

This very distinct species was known only from a damaged specimen, 52 mm long, from the Manila market. I have a small but perfect specimen, 32 mm long, gathered from the mud flats at Opon, Mactan Island. The caudal is rounded rather than pointed, and is not as long as the head but is equal to the head without the snout.

CALLIONYMIDÆ

CALLIURICHTHYS FILAMENTOSUS (Cuvier and Valenciennes).

A fine male specimen, 76 mm long, or 107 mm with the caudal, was dredged from Manila Bay. New to the Philippines and known previously from Celebes and Amboina.

Dorsal I–III, 9; anal 9; caudal 14 (?).

The very large pointed head is as broad as long, measured to the gill opening, 3.8 times in the length; the caudal is almost half as long as the head and body; the hairlike first dorsal spine reaches to the posterior half of the second dorsal, 2.7 times, the last dorsal ray 5, the last anal ray 6.3, the pectoral 5, the ventral 4.47 times in the length. The eye is 3.33, the snout

2.85 times in the head; the straight opercular spine is slightly serrated above, about as long as the snout, and has a forward-pointing process above, near its base. The last dorsal and anal rays and the two middle caudal rays are much elongated, with more or less filamentous tips.

The color in alcohol is uniform reddish brown, the upper half with paler lobate spots; on the side, below the lateral line, are four irregular rows of black dots. The first dorsal has four black wavy crossbands; the second dorsal and pectoral are barred with black dots, the caudal by dark bands; the anal is clear with a dusky margin; the ventrals are reddish brown, with dark dots and mottlings.

TRICHONOTIDÆ

TRICHONOTUS SETIGERUS (Bloch and Schneider).

Two perfect specimens, 50 and 78 mm long, of this rare and elongate little fish were caught in Pansipit River, near the outlet of Lake Bombon, Batangas Province, Luzon. Previously known in the Philippines from specimens obtained on the east coast of Mindoro.

Dorsal 46 to 49; anal 36 to 38; scales in the lateral line 55 to 58, plus 2 on the caudal base.

The depth is 13, the breadth 15.6, the head 4.9, the caudal 7 times in the length; the eye is 5.33, the snout 3.55, the maxillary 3.2 times in the head. The strongly projecting lower jaw has a terminal papilla projecting upward above the snout tip; the mouth is large, the maxillary reaching beneath the front margin of the pupil.

The color in alcohol is yellowish gray thickly strewn with dark brown above, and with thirteen broad brown crossbands over the back; the first two are before the first dorsal, the last one on the caudal base; the sides of the head are clear with five large dark brown circular spots, evidently ocelli in life. The first four dorsal rays are black with a white or colorless crossband on the upper half; the other fins colorless, except the caudal which is dark brown with crossbands of white spots.

BLENNIIDÆ

ANDAMIA CYCLOCHEILUS M. Weber.

Andamia cyclocheilus M. WEBER, Fische Siboga Exped. (1913) 538, pl. 3, fig. 3.

Dorsal XV, 19 or 20; anal 24 to 26.

A specimen of this strange blenny, 66 mm long, was taken at Puerto Galera, Mindoro. New to the Philippines. Its color is

uniformly blue-black, without spots or bands, the fins brownish black.

The depth is 7.33, the head 5.5, the caudal 3.3, the pectoral 5 times in the length; the eye is 3, the snout 2.4, the interorbital 4, the ventral 2.4 times in the head. The second and third dorsal spines are a little elongated. There is a fimbriated ocular tentacle.

I also collected 20 examples, 28 to 77 mm long, near Menado, Celebes. Large males have the anterior dorsal spines, or all the dorsal spines, except the first, much elongated. The caudal rays are undivided, their tips filiform and free. A male 77 mm long has the depth equal to the head, 6 times, the caudal 3.35, the pectoral 5.1, the ventral 11, the second dorsal spine 3.2 times in the length; the eye and interorbital are equal, 4.33 times, the snout and ventral each 1.85 times in the head.

The color in alcohol is uniform purplish brown, with or without paler violet or whitish spots and short irregular bars over the head, back, and sides; the dorsal, caudal, and pectoral are brown, violaceous, or colorless; the anal may be colorless, or blackish blue with white margin; the ventral white.

From *Andamia expansa* Blyth this species is separated by the shape of its adhesive sucker, which is a semicircular or oval disk behind the mouth, instead of the double-pointed one of *A. expansa.*

Previously known only from one specimen from New Guinea, three from Flores, and one from the "East Indies."

CRISTICEPS XANTHOSOMA (Bleeker).

Dorsal III–XXVII, 4; anal II, 19.

The depth is 4, the head 3.48, the caudal and pectoral each 5.55, the ventral 6.1 times in the length; the eye is 4.16, the snout 5, the maxillary 2.7, and the interorbital 7 times in the head.

The deep body is laterally compressed, the ventral profile strongly convex; the head is moderately arched from the dorsal origin to the tip of the projecting lower jaw; the eyes are high up, lateral, with a fimbriate tentacle on the margin of each, half or more than half the eye in length; a small simple nasal tentacle; the mouth is strongly oblique, the maxillary extending beneath the front margin of the pupil; the small teeth form a band of five rows in front, dwindling to a single row posteriorly, alike in both jaws; minute teeth on vomer and palatines. The dorsal spines are all hard and sharp-pointed, with only four divided rays at the posterior end of the dorsal fin; the anal spines are

likewise hard and sharp. The vertical fins are low, the first dorsal spine 2.5 in the head; the second dorsal is uniform in height, 3.18 in the head, the first dorsal ray equal to the first dorsal spine; the anal rays are of uniform height, 2.9 in the head.

The color in alcohol is uniform yellow, all fins as well as body.

This handsome blenny, previously unknown in the Philippines, is represented by a specimen 61 mm long, from a reef at Paraoir, La Union Province, Luzon. Hitherto known only from Java, from specimens described by Bleeker in 1857.

PETROSCIRTES TÆNIATUS (Quoy and Gaimard).

This lovely blenny is one of the handsomest denizens of the coral reefs of the East Indies and Polynesia. Though not rare it is difficult to collect. A specimen 93 mm long from Calapan, Mindoro, is apparently the first recorded from the Philippines. I have seen it at Dumaguete, and at various places in the Sulu Archipelago, but have been unable to secure specimens.

In life it is a beautiful blue with a black band from the tip of the snout to the tip of the caudal fin, narrow anteriorly and more than twice as wide posteriorly; the dorsal and anal have a narrow white margin. In alcohol the blue fades considerably, the colors otherwise unchanged.

This fish swims with a peculiar rocking and twisting motion, inclined first to one side and then to the other as it speeds swiftly forward.

ILLUSTRATIONS

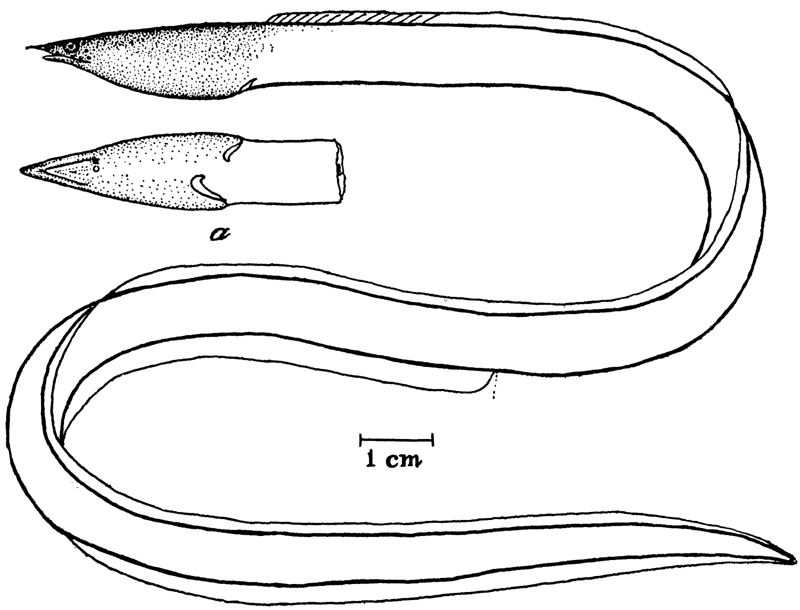
[Drawings by P. Bravo.]

PLATE 1

FIG. 1. *Cæcula philippinensis* sp. nov.; *a*, under side of head showing irregular position of gill openings.
2. *Syngnathus martini* sp. nov.
3. *Vaimosa montalbani* sp. nov.

PLATE 2

FIG. 4. *Ctenogobius villadolidi* sp. nov.
5. *Schismatogobius roxasi* sp. nov.
6. *Mars haydeni* sp. nov.
7. *Salarias fowleri* sp. nov.



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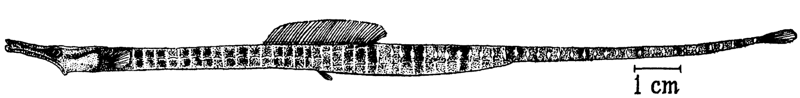

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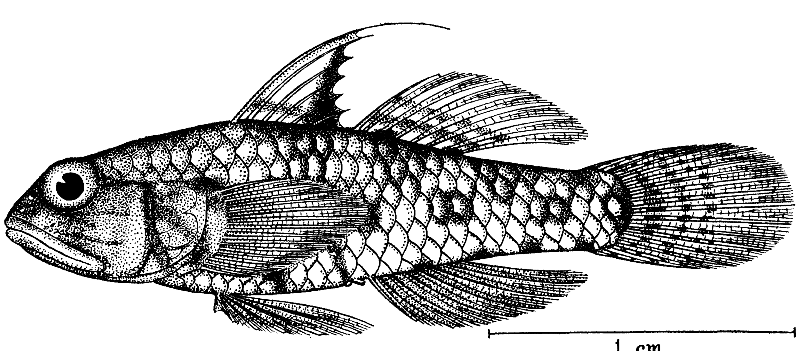

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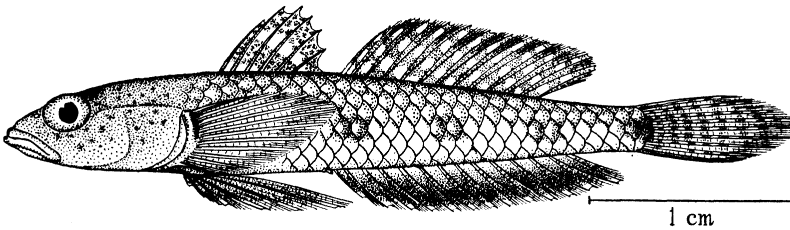
PLATE 1.



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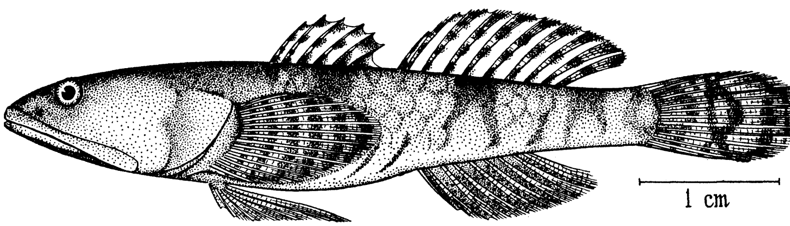

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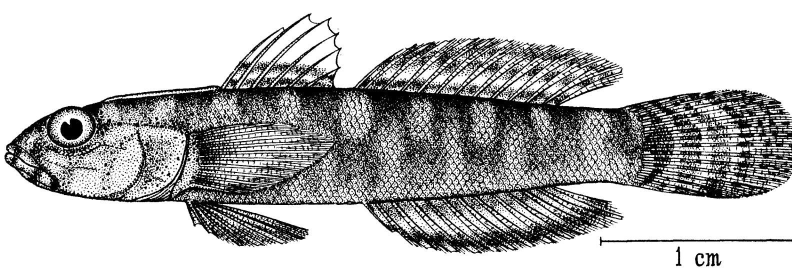

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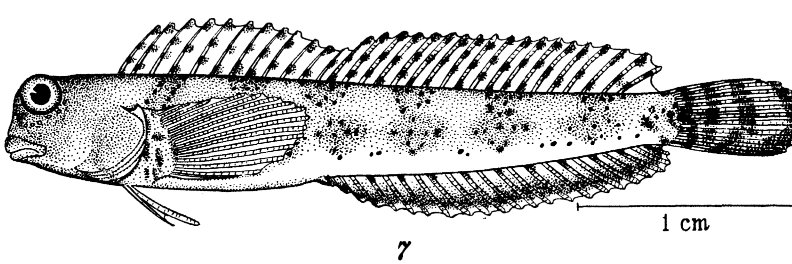

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PLATE 2.

A NEW PHALLOSTETHID FISH WITH NOTES ON ITS DEVELOPMENT

By Porfirio R. Manacop

Of the Fish and Game Administration, Bureau of Science, Manila

TWO PLATES

August 27, 1935, some live phallostethid fishes were caught in a gourami pond at Barrio Laput, Mexico, Pampanga. Only ten living females, presumably impregnated, reached the laboratory in Manila, all the males having died on the way. They were placed in a balanced aquarium, and the following morning some eggs were found attached by some adhesive thread-like processes to leaves of *Anacharis*. They were transferred to petri dishes and their development followed and studied.

A close examination of the adult showed that this fish is a new species. Three genera and five species of Phallostethidæ are now known in the Philippine Islands, two species in brackish water and three in fresh-water streams and ponds. *Gulaphallus mirabilis* was first reported by Herre (1925) from Ipo Creek, Bulacan, and Molawin Creek, Los Baños, Laguna; *G. eximius* Herre (1925) from a creek at Santa Fe, Nueva Vizcaya; *Mirophallus bikolanus* Herre (1926) from Lake Lanigay, Albay Province; *Gulaphallus amaricola* Villadolid and Manacop (1934) from the sloughs of Manila Bay in Pasay, Rizal; *Plectrostethus palawanensis* Myers (1935) from the mouth of Caiholo River, Ulugan Bay, Palawan; and *Gulaphallus falcifer* sp. nov. from gourami ponds at Mexico, Pampanga, and Nampicuan, Nueva Ecija.

GULAPHALLUS FALCIFER sp. nov. Plate 1, figs. 1, 1a; 2, 2a.

Head 2.9; depth 5.42 (male), 4.56 (female); first dorsal II; second dorsal I, 6; pectoral 9; anal I, 15–16; caudal 30; scales 30 to 32 in median lateral series; 7 in transverse series counted from base of second dorsal to posterior end of anal; 14 to 16 predorsal scales.

Body compressed laterally, dorsal profile very slightly elevated, ventral profile strongly convex in the female; greatest depth at level of anal origin; body tapering gradually to caudal base, least depth of caudal peduncle 1.88 in body.

Head small, with bluntly rounded snout and more or less projecting chin. Mouth small and nearly vertical, lower lip slightly greater than the upper. Teeth finely pointed in two rows, in both jaws. Upper maxillary not extending beyond margin of eye. Eyes large, 2.71 in head, impinging on dorsal head profile. Interorbital space flat, equals eye. Three to four branchiostegal rays prominent and clearly visible externally.

First spinous dorsal soft and very short, inserted directly above base of sixth anal ray. Second dorsal about 1.8 in head, inserted above tenth anal ray. Pectorals with rather thick muscular bases, shorter than head, second ray longest. Ventrals absent. Base of anal fin about three times that of second dorsal, the first ray longest. Caudal not deeply forked, about 1.2 times greater than head.

Male with one greatly curved, slender ctenactenium, articulating from lateroposterior part of priapium. Tip of ctenactenium strongly curved, resting in a groove formed by chin and anterior end of priapium. Pulvinulus (Plate 1, fig. 1) shieldlike, narrower but longer than eye, free along its anterior and ventral margins. A fleshy, tubular, somewhat laterally directed structure, possibly the intromittent organ (Plate 1, fig. 1a, *io*) and formed by the terminal portion of the coiled vas deferens located at posterior end of priapium.

Female with a scythelike osseous postanal papilla (Plate 1, figs. 1, 3 and 4, *pl*) about 3 mm in length, originating medially from a point just below base of pectoral and a little behind anal opening; papilla covers openings of oviduct and ureter.

In life body transparent, gill regions reddish, fins colorless and transparent. A distinct dark blotch, darker in female, on abdominal region just anterior to anal fin origin. A prominent minute dark spot on vertex, pectoral base, and chin. A fine dark line along base of anal. A median dark line originating from about base of pectoral to caudal base.

The fish closely resembles *Neostethus lankesteri* Regan (1916) in general appearance, but differs markedly from this in the absence of comblike projections located at the posterior end of the priapium in the male and the presence of a well-developed postanal papilla in the female. The position of the postanal papilla is similar to that in *Neostethus bicornis* Regan (1916). *Neostethus bicornis* Regan, however, has a pair instead of a single enlarged papilla. Myers (1928) claims that the papilla perhaps represent the pelvic fins, while Regan (1913) calls them pelvic fins in his description of *Phallostethus dunckeri*.

Here described from the holotype, Philippine Fish and Game Administration No. 31778, adult male, 27.5 mm standard length (34.0 mm total length), collected by C. Sandiko in a gourami pond at Barrio Laput, Mexico, Pampanga Province, Luzon, August 27, 1935.

Allotype.—F. G. A. No. 31779, adult, female, 26.5 mm standard length (23 mm total length). The same locality and date.

Paratypes.—F. G. A. No. 31780, 17 specimens (20 to 34 mm); 8 females and 9 males. The same locality and date.

Falcifer, a scythe-bearing individual.

EMBRYOLOGY OF GULAPHALLUS FALCIFER SP. NOV.

The newly laid eggs were transferred to petri dishes, and the tap water was changed daily up to the time of hatching.

All observations and illustrations were made exclusively on living material. The embryonic development of the egg was followed up to the time of hatching.

The newly laid eggs.—The eggs (Plate 2, fig. 1) are highly transparent, spherical, 1 to 1.1 mm in diameter. They are demersal and held together in ropy clumps by a tangle of adhesive threadlike processes (*at*). A tuft of these processes arising from a point on the egg membrane of each egg attaches it to leaves and stems of aquatic plants.

Ten to fifteen large oil globules of different sizes and numerous small ones are discernible in the egg.

Incubation period.—The incubation period under laboratory conditions in August, 1935, lasted from nine to eleven days.

Later cleavage stages to formation of the primitive streak.—The day after it is laid, the egg is observed to be in an advanced stage of cleavage. Plate 2, fig. 2, shows the blastoderm covering almost one-third of the egg. The periblast (*pb*) is also in evidence. On the third day after laying, the germ ring becomes manifest (Plate 2, fig. 3). It appears as a thickened peripheral zone of the blastoderm (fig. 3, *gr*). Before the germ ring is fully evident, invagination probably has advanced more rapidly at one pole than on the rest of the periphery of the blastoderm. This process results in the formation of the embryonic pole (fig. 5, *pp*). At this pole a broad tonguelike group of cells is pushed toward the cleavage cavity (fig. 5, *c*). This marks the early stage of the embryonic shield (fig. 5, *es*).

The blastoderm increases in size very rapidly, and the germ ring advances around the yolk. During this time the embryonic shield grows larger and becomes more definitely outlined. Four

hours from the formation of the germ ring there occurs a linear thickening along the anteroposterior axis of the embryonic shield. This linear thickening is the primitive streak, and marks the axis of the embryo, which now extends over about one-third of the surface of the egg.

Later embryonic stages.—Four days after the egg is laid the optic vesicles and ten to twelve somites are in evidence (Plate 2, fig. 6, *s*). Small rounded black dots, which first appear on the dorsoposterior aspect of the head, later develop into pigmented processes. The heart, which appears like an ovoid sac along the throat region, becomes recognizable on the fifth day after laying. At this time the heart begins to beat slowly. The embryo, which is now fully recognizable, extends over more than half of the yolk sphere. The membranous fold, which extends from the middorsal region around the caudal end and along the ventral side of the embryo, is already in evidence.

Embryonic circulation commences six days after laying (Plate 2, fig. 8). The beating of the heart at this time is comparatively faster than on the fifth day. The head becomes relatively broad, and the body tapers gradually toward the posterior end.

Seven days after the egg is laid the primordia of the pectoral fins (Plate 2, fig. 9, *p*) become evident. They appear as uneven triangular protrusions at the pectoral region. The eyes become pigmented. The head has grown considerably in size, and the embryo has grown over the yolk sphere completely. The chromatophores have increased on the dorsal aspect of the head and trunk.

As the time of hatching approaches, the embryo grows larger and the yolk becomes materially reduced (Plate 2, figs. 10 and 11). A network of blood vessels becomes evident over the surface of the yolk sphere. The black pigments have grown larger and more numerous, and the embryo begins to wiggle furiously. The pectoral fin primordia have developed into ovate pectoral fins. Nine days after the egg is laid, the young fish becomes liberated from the egg membrane and begins to swim about.

The newly hatched fish.—The newly hatched fish (Plate 2, fig. 12) is approximately 3.5 mm in length. The head is large, more or less flattened ventrally, and strongly convex dorsally. The eyes are large and bulge out of their sockets. The semiovoid yolk sac, which has a few scattered pigments spots, remains relatively large. The vent is located just behind the margin of the yolk sac. The body tapers gradually from the vent towards the posterior end. The fin folds and the posterior

caudal region of the body remain entirely free from pigments. The chromatophores have developed into large blotches on the dorsal aspect of the head, and numerous small ones are distributed along the dorsal aspect of the body and along the upper border of the notochord.

The newly laid egg of *G. falcifer* differs from that of *G. mirabilis* (Villadolid and Manacop, 1934) in that the former has fewer oil globules. Moreover, while the threadlike processes of the egg of *G. falcifer* arise from a common base, those of *G. mirabilis* are scattered over the egg membrane. This mode of attachment of the threadlike processes in *G. falcifer* is similar to that of *Menidia menidia notata* (Kuntz and Radcliffe, 1916), a close relative of the species.

In the length of the incubation period under laboratory conditions, *G. mirabilis* and *G. falcifer* do not differ widely, the period being from eight to eleven days.

The embryonic development of *G. falcifer* is entirely typical of the teleostean egg and does not differ essentially from that of *G. mirabilis.* The difference lies only in the time of the differentiation of the various embryonic parts. This may be attributed to the difference in conditions obtaining during the observations.

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ILLUSTRATIONS

[Drawings by Angel D. Lagman.]

PLATE 1

[*pv*, Pulvinulus; *ct*, ctenactinium; *io*, intromittent organ; *a*, anus; *o*, opening of oviduct; *pl*, postanal papilla; *i*, intestine; *ov*, ovary.]

FIG. 1. *Gulaphallus falcifer* sp. nov., male; 1a, ventral aspect of head region of male (× 7).

2. *Gulaphallus falcifer* sp. nov., female; 2a, ventral aspect of head region of female (× 7).

3. Head portion of female made transparent to show relative position of papilla to internal organs.

4. Bone of papilla removed and enlarged (× 20).

PLATE 2. EGGS OF GULAPHALLUS FALCIFER SP. NOV.

FIG. 1. A group of newly laid eggs attached by adhesive threads to a portion of a leaf of *Elodea* (× 30); *at*, adhesive threads.

2. Egg with blastoderm in late cleavage stage (× 40); *bl*, blastoderm.

3. Germ-ring stage; *gr*, germ ring; *pp*, posterior pole; *c*, cleavage cavity; *es*, embryonic shield.

4. Primitive-streak stage; *ps*, primitive streak.

5. Egg with advanced embryo with 10 to 12 somites (lateral view); *sm*, somites; *p*, black pigments.

6. Same as fig. 5 (top view).

7. Fifth-day embryo; *h*, heart.

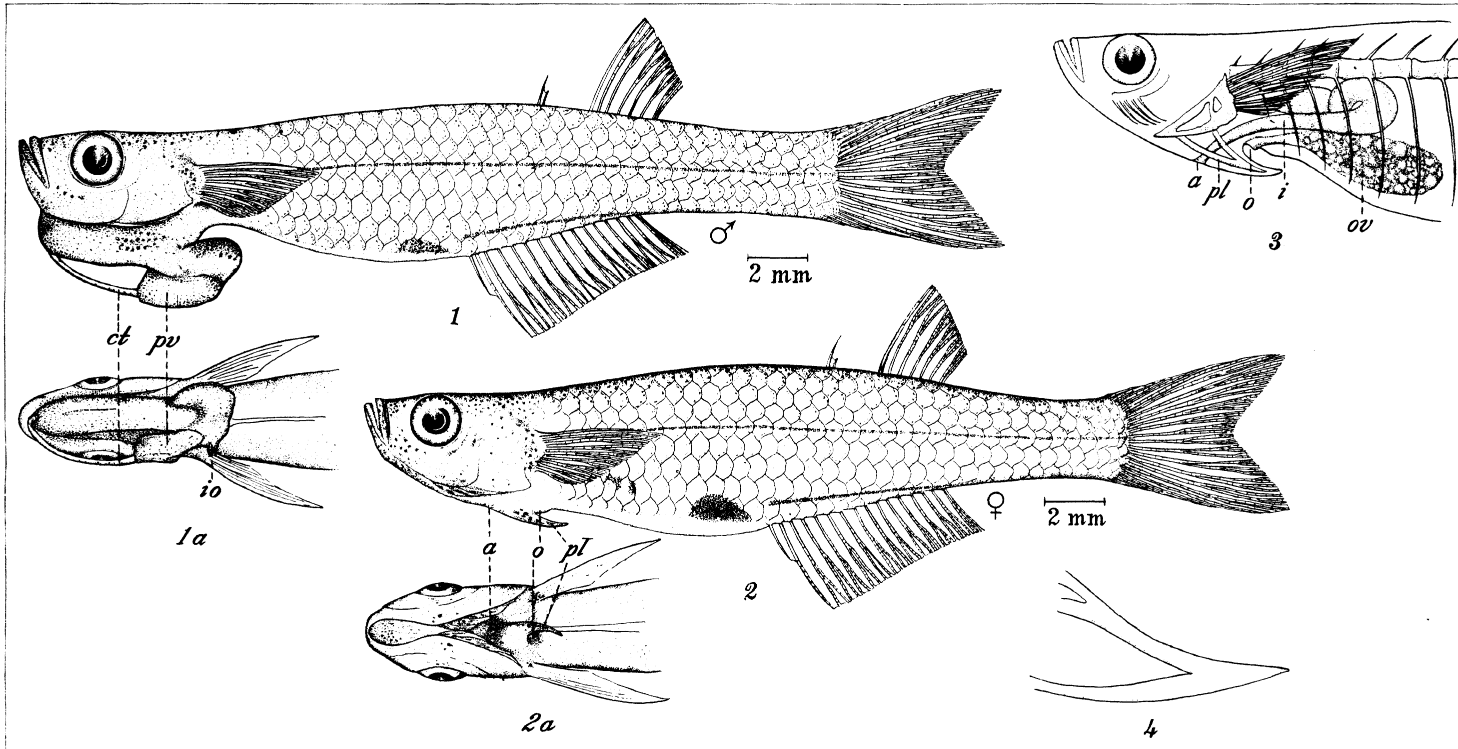
8. Sixth-day embryo.

9. Seventh-day embryo; *pp*, pectoral primordia.

10. Eighth-day embryo; *pf*, pectoral fin.

11. Ninth-day embryo.

12. Newly hatched fish (× 5); *v*, vent; *ys*, yolk sac.



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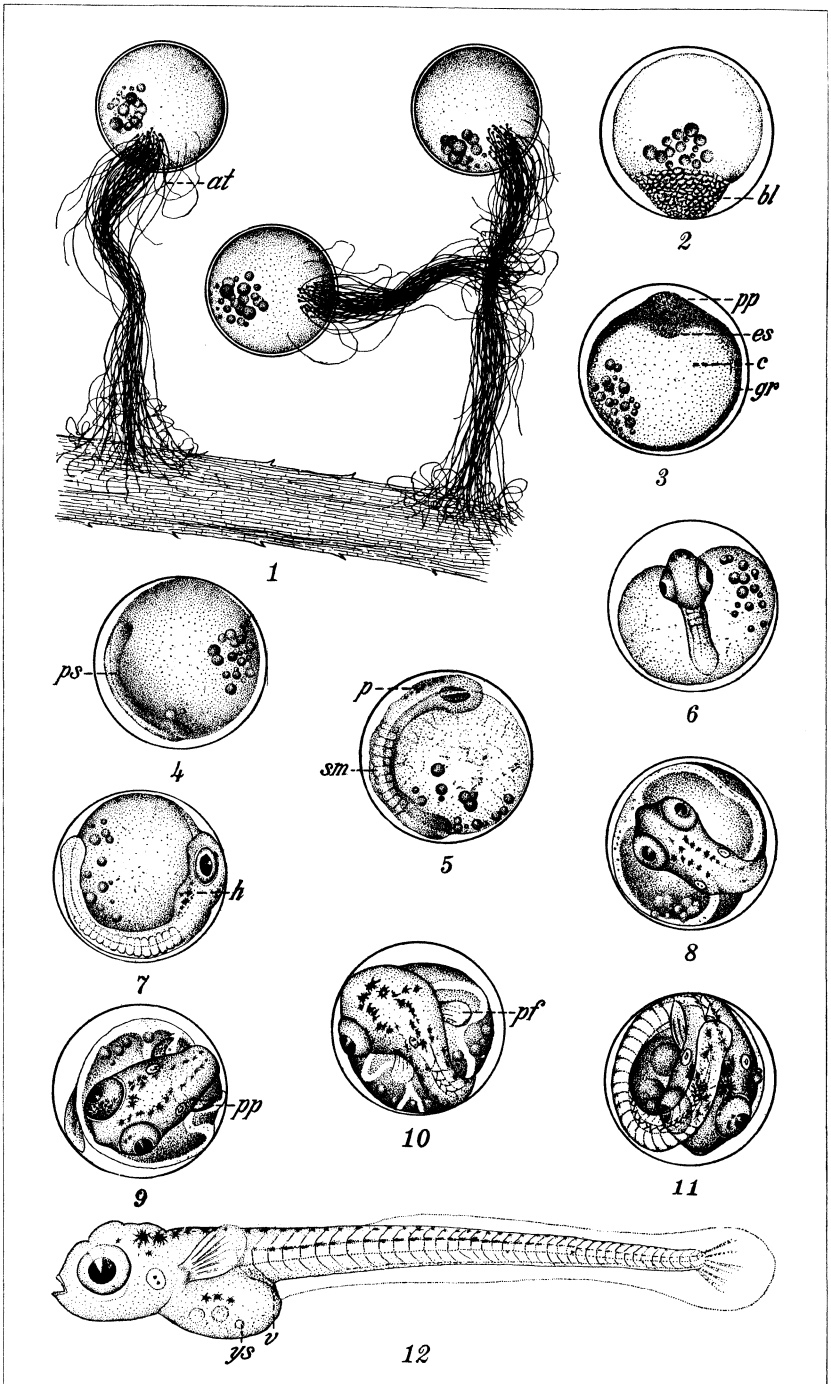

PLATE 2.

THE SEXUAL MATURITY OF SOME COMMERCIAL FISHES CAUGHT IN MANILA BAY

By Porfirio R. Manacop

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Because of its rich fishery resources and its proximity to Manila markets, Manila Bay is perhaps the best fishing center of the Philippines. It has an approximate area of 720 square miles,[1] an average depth of about 3 to 4 fathoms, and a more or less smooth and muddy bottom suitable for fish-trawling.

There are now about seventy-three beam trawlers operating in Manila Bay. This number slightly changes from time to time as a few trawlers shift to other fishing grounds like Ragay and Lingayen Gulfs and waters adjacent to Negros. The majority of them, however, operate in Manila Bay throughout the year.

The rapid increase of gears and the redoubling of effort in the catching of fish in this limited body of water would in the long run, if not restricted, lead to the depletion of its fishery resources. The study, therefore, of the size limits of the commercial fishes caught in Manila Bay is urgently needed in order to have some basis for regulating these beam trawlers. The regulations would in turn reduce the enormous waste in the form of unmarketable and immature fishes which are unavoidably caught by these gears.

This is the first study of this nature on Philippine marine fishes, and the literature on the subject is rather scanty. Most of the studies on the species treated in this paper deal with their taxonomy, with some notes on their distribution and habitat. Walford (1932) reported the size and age groups and the breeding habits at sexual maturity of the California barracuda (*Sphyræna argentea*).

Some extensive work of this nature had already been done by Mane (1929 and 1932) on fresh-water fishes of Laguna de Bay, specifically on *Arius* spp., Arridæ, and on *Mesopristes plumbea* Kner, Theraponidæ.

[1] Port of Manila; Year Book (1931) 1–43.

The absence of winter markings on the scales and otolith bones of tropical fishes is a handicap in the study of age at sexual maturity of Philippine fishes. An additional difficulty is that the spawning of most species of fishes in the Philippines is not confined to a part of the year, but takes place all the year round. The determination of age was, therefore, dispensed with and the work was confined to the study of the size groups at sexual maturity.

This paper is a study on the determination of the size limits of some of the commercial fishes caught in Manila Bay. These fishes are the following:

1. *Johnius aneus* (Bloch); plain croaker; Sciænidæ; Tagalog name: Alakaak.
2. *Gerres filamentosus* Cuvier and Valenciennes; spotted mojarras; Gerridæ; Tagalog name: Malakapas.
3. *Nemipterus japonicus* (Bloch); long-tailed nemipterid; Nemipteridæ; Tagalog name: Bisugong buntutan.
4. *Saurida tumbil* (Bloch); common lizard fish; Synodontidæ; Tagalog name: Kalaso.
5. *Sphyræna jello* Cuvier and Valenciennes; banded barracuda; Sphyrænidæ; Tagalog names: Torcillo (small), asogon (large).
6. *Sphyræna obtusata* Cuvier and Valenciennes; striped barracuda, Sphyrænidæ; Tagalog names: Torcillo (small), asogon (large).

The first four named form a large part of the hauls of the beam trawls in Manila Bay. At times fish corrals also catch these species in considerable quantities. The last two species are hard-fighting game fishes, sought by sport anglers, and are caught in small quantities in fish corrals in Manila Bay.

METHODS

Collection of material.—The material for this study was collected from September, 1934, to April, 1935, inclusive. The material, which consisted of from ten to twenty specimens in a sample a week, was mostly taken from the catch of the Japanese beam trawls operating in Manila Bay. The catch of the fish corrals operating in the Bataan portion of Manila Bay offered also a considerable amount of material. The material was preserved in 10 per cent formalin for about twenty-four hours and transferred to 70 per cent denatured alcohol before examination.

Measurements.—The measurements of the fish are usually made after they have been preserved in 70 per cent alcohol. The standard and total lengths of each fish examined are taken. All measurements are made by means of a measuring board with the aid of a dividers and a millimeter rule. The measure-

ments of the ova are made under a compound microscope with an ocular micrometer. The sample of ova taken at the middle portion of the ovary is teased out on a collumned glass slide and measured. By this method the error of measuring any ovum twice is minimized.

Determination.—The maximum, minimum, and average sizes at sexual maturity of both sexes whenever possible are ascertained. For the males the presence of milt when pressed and the whiteness and enlargement of the testes are taken as criteria for sexual maturity. The presence of maturing eggs is taken as an index for the maturity of the females. Most males are examined while in the fresh state, their maturity being easily determinable.

The gross examination of the ovary to ascertain the maturity of the female is aided by measurement and examination of the ova. In addition certain criteria that make it possible to differentiate, with the unaided eye, the ovaries into those that contain immature eggs, maturing eggs, and mature eggs are being used. In most of the females studied those with immature ovaries have ova that could not be seen by the naked eye, those that had maturing ovaries are granulated in appearance and have creamy white ova, while those with mature ovaries are yellowish to orange or translucent and have large ova loosely attached or completely free from the walls of the ovary.

SIZE AT SEXUAL MATURITY

1. *Johnius aneus* (Bloch); alakaak; Sciænidæ. Tables 1 and 5 show the results of the determination of the sexual maturity of the fish. Of the 479 males examined, 231 were mature and 248 immature. The male alakaak begins to mature at a minimum length of 11.5 centimeters. About 56 per cent of the males dissected were found to mature at 11.5 centimeters, about 78.94 per cent at 12 centimeters, and about 85 per cent at 12.5 centimeters. All males examined measuring 12.6 centimeters or more in length were sexually mature.

The female alakaak appears to mature at a length group of 11.5 to 12.6 centimeters. It may be seen from the table that both sexes mature within the same range. The average size at sexual maturity of both sexes is about 12 centimeters. Of the 403 females examined, 193 were mature and 210 immature. About 63.15 per cent of the females dissected were mature at a minimum of 11.5 centimeters, 70.33 per cent at 12 centimeters, and 83.33 per cent at 12.5 centimeters. Invariably,

females measuring 12.6 centimeters or more in length were mature.

TABLE 1.—*Size groups of sexually mature Johnius aneus (alakaak).*

Standard length.	Males.			Females.		
	Total.	Mature.	Per cent.	Total.	Mature.	Per cent.
cm.						
7.0– 7.5	19			13		
7.6– 8.0	24			16		
8.1– 8.5	38			28		
8.6– 9.0	40			31		
9.1– 9.5	26			38		
9.6–10.0	31			20		
10.1–10.5	32			23		
10.6–11.0	21			23		
11.1–11.5	23	13	56.52	19	12	63.15
11.6–12–0	19	15	78.94	27	19	70.37
12.1–12.5	20	17	85.00	18	15	83.72
12.6–13.0	25	25	100.00	18	18	100.00
13.1–13.5	19	19	100.00	17	17	100.00
13.6–14.0	23	23	100.00	15	15	100.00
14.1–14.5	31	31	100.00	25	25	100.00
14.6–15.0	28	28	100.00	19	19	100.00
15.1–15.5	13	13	100.00	12	12	100.00
15.6–16.0	13	13	100.00	18	18	100.00
16.1–16.5	12	12	100.00	12	12	100.00
16.6–17.0	0	0	00.00	0	0	00.00
17.1–17.5	0	0	00.00	11	11	100.00
17.6–18.0	11	11	100.00			
18.1–18.5	11	11	100.00			
Total	479	231		403	193	

2. *Gerres filamentosus* Cuvier and Valenciennes; malakapas; Gerridæ. Tables 2 and 5 show the size groups of sexually mature malakapas. Of the 175 males examined, 140 were sexually mature and 35 immature. The male begins to mature at a minimum size of 7.5 centimeters. At this size 12.5 per cent of the males examined were mature; about 58.33 per cent were mature at 8 centimeters and 85 per cent at 8.5 centimeters. At a maximum size of 9 centimeters all males examined were sexually mature, and all males above 9 centimeters in length were mature. The average size at sexual maturity of the male malakapas is 8.6 centimeters.

The female malakapas matures at a minimum size of 7 centimeters, like the male, at a maximum size of 8.5 centimeters, and at an average size of 7.9 centimeters. About 58.33 per cent of the females examined mature at this minimum size, and 95 per cent at 8 centimeters; females measuring 8.5 or more in length were mature. It may be seen further from Table 2 that

more females reach sexual maturity than males at size groups of from 7.1 to 8.5 centimeters. Of the 176 females examined, 167 were mature. The average size at sexual maturity of the female is about 7.9 centimeters. The majority of the samples examined were mature.

TABLE 2.—*Size groups of sexually mature Gerres filamentosus (malakapas).*

Standard length.	Males.			Females.		
	Total.	Mature.	Per cent.	Total.	Mature.	Per cent.
cm.						
6.5– 7.0	13			3		
7.1– 7.5	16	2	12.50	12	7	58.33
7.6– 8.0	12	7	58.33	20	19	95.00
8.1– 8.5	20	17	85.00	35	35	100.00
8.6– 9.0	28	28	100.00	26	26	100.00
9.1– 9.5	28	28	100.00	29	29	100.00
9.6–10.0	33	33	100.00	25	25	100.00
10.1–10.5	15	15	100.00	12	12	100.00
10.6–11.0	4	4	100.00	8	8	100.00
11.1–11.5	2	2	100.00	5	5	100.00
11.6–12.0	1	1	100.00	1	1	100.00
12.1–12.5	1	1	100.00			
12.6–13.0	1	1	100.00			
13.1–13.5	1	1	100.00			
Total	175	140		176	167	

3. *Nemipterus japonicus* (Bloch); bisugong buntutan; Nemipteridæ. The testes of this fish appear to be poorly developed in all the size groups examined. This makes it difficult to ascertain the state of maturity of the males; hence, the determination of its maturity was dispensed with.

TABLE 3.—*Size groups of sexually mature female Nemipterus japonicus (bisugong buntutan).*[a]

Females.							
Standard length.	Total number.	Mature.	Per cent.	Standard length.	Total number.	Mature.	Per cent.
cm.				*cm.*			
6.0– 6.5	12			11.1–11.0	20	20	100.00
6.6– 7.0	16			11.6–12.0	13	13	100.00
7.1– 7.5	31	16	51.61	12.1–12.5	12	12	100.00
7.6– 8.0	47	29	61.72	12.6–13.0	12	12	100.00
8.1– 8.5	69	55	79.71	13.1–13.5	10	10	100.00
8.6– 9.0	49	49	100.00	13.6–14.0			
9.1– 9.5	32	32	100.00	14.1–14.5			
9.6–10.0	28	28	100.00	14.6–15.0			
10.1–10.5	23	23	100.00	Total	406	321	
10.6–11.0	22	22	100.00				

[a] No determination was made for the males.

The female bisugo matures at a minimum size of 7.6 centimeters, at a maximum size of 8.1 centimeters, and at an average size of 7.9 centimeters long (Tables 3 and 5). Of the 406 females examined, 321 were sexually mature and 85 were immature. About 51.61 per cent of the females examined were mature at the minimum size, about 61.72 per cent at 8 centimeters, and about 79.71 per cent at 8.5 centimeters. Females measuring 8.6 centimeters or more in length were all mature.

4. *Saurida tumbil* (Bloch); kalaso; Synodontidæ. Tables 4 and 5 show the results of the determination of the size at sexual maturity of kalaso. Of the 195 males examined, 158 were immature and 37 sexually mature. The male matures at size groups of from 18.5 to 21 centimeters long. About 50 per cent of the males examined were mature at 19 centimeters, about 53.72 per cent at 20 centimeters, and about 77.79 per cent at 21 centimeters. Invariably, all males longer than 21 centimeters were mature.

TABLE 4.—*Size groups of sexually mature Saurida tumbil (kalaso).*

Standard length.	Males.			Females.		
	Total.	Mature.	Per cent.	Total.	Mature.	Per cent.
cm.						
10.0–11.0	5			15		
11.1–12.0	16			27		
12.1–13.0	21			39		
13.1–14.0	26			44		
14.1–15.0	21			34		
15.1–16.0	17			22		
16.1–17.0	14			18		
17.1–18.0	16			20		
18.1–19.0	16	8	50.00	15	6	40.00
19.1–20.0	26	14	53.72	30	14	46.66
20.1–21.0	9	7	77.79	26	14	53.72
21.1–22.0	6	6	100.00	14	13	92.85
22.1–23.0	2	2	100.00	2	2	100.00
23.1–24.0				1	1	100.00
24.1–25.0						
25.1–26.0						
26.1–27.0						
27.1–28.0						
28.1–29.0						
Total	195	37		305	52	

The female kalaso begins to mature at from 18.5 to 22.1 centimeters. Of the 305 females dissected, 253 were immature and 52 mature. About 40 per cent were mature at 19 centimeters, 46.66 per cent at 20 centimeters, about 53.72 per cent at 21 centimeters, and about 92.55 per cent at 22 centimeters.

All females measuring 22.1 centimeters or more in length were invariably mature. The average sizes at sexual maturity of the male and female kalaso were 19.5 and 20.5 centimeters, respectively. It may be seen also from Table 1 that the beam-trawl catch of this species appears to show the preponderance of the immature group of both sexes.

5. *Sphyræna jello* Cuvier and Valenciennes; banded barracuda; Sphyrænidæ. The banded barracuda ordinarily reaches a length of from 1 to 1.5 meters. However, a specimen 10 feet long has been reported in Leiden, Holland, Buttikofer (1890).

From an examination of about 60 specimens collected from March to April, 1935, it was found that the male begins to mature at a total length of 32.4 to 34.1 centimeters with an average of 33.3 centimeters (Table 5). All males measuring 33.3 centimeters or more in length were sexually mature.

The female, however, matures at a total length of 32.5 to 34.9 centimeters with an average of 34.2 centimeters. All females longer than 34.9 centimeters were invariably mature.

TABLE 5.—*The minimum, maximum, and average lengths at sexual maturity of the fishes studied.*

Scientific name.	Minimum.		Maximum.		Average.	
	Male.	Female.	Male.	Female.	Male.	Female.
	cm.	*cm.*	*cm.*	*cm.*	*cm.*	*cm.*
Johnius aneus	11.5	11.5	12.6	12.6	12.1	12.0
Gerres filamentosus	7.0	7.0	9.0	8.5	8.6	7.9
Nemipterus japonicus	([a])	7.5	([a])	9.0	([a])	8.4
Saurida tumbil	18.5	18.5	21.1	22.1	19.5	20.5
Sphyræna jello	32.4	32.5	34.1	34.9	33.3	34.2
Sphyræna obtusata	21.5	22.1	23.7	23.4	22.8	22.9

[a] No determination was made.

The barracuda probably spawns from the later part of March to the early part of May. This is evidenced by the presence of rapidly maturing and a few mature eggs in some parts of the ovaries examined during March and April, 1935. This is corroborated by the observation of Prof. Luis Reyes, of the Bureau of Forestry. He noted after examining a number of individuals that during March, April, and May the barracudas were spawning or breeding around Look, Batangas Province. Walford (1932) reported that the California barracuda (*Sphyræna argentea*) spawns from April to September, indicating that the temperate region barracuda has a prolonged spawning season as compared with the Philippine barracudas.

The foregoing conclusions on the spawning of barracudas in the Philippines should be considered tentative only, on account of the fact that the observations were carried on for a short period.

6. *Sphyræna obtusata* Cuvier and Valenciennes; striped barracuda; Sphyrænidæ. The striped barracuda, which is the smaller of the two species, is also caught in fish corrals in Manila Bay. It reaches a length of about 40 centimeters.

Of the 50 specimens dissected, it was found that the male matures at a total length of 21.5 to 23.7 centimeters with an average of 22.8 centimeters. All males measuring 23.7 centimeters or more in length were mature.

The female, on the other hand, matures at a total length of 22.1 to 23.4 centimeters with an average of 22.9 centimeters. Like the banded barracuda it probably spawns from late in March to early in May as evidenced by the presence of ripe ova in some of the ovaries examined.

CONCLUSIONS AND RECOMMENDATIONS

1. The male and female alakaak mature at from 11.5 to 12.6 centimeters with an average length of about 12 centimeters.

2. The sexual maturity of malakapas ranges from 7 to 9 centimeters in the male and 7 to 8.5 centimeters in the female, while the average lengths are 8.6 and 7.9 centimeters, respectively.

3. The sexual maturity of the female bisugong buntutan ranges from 7.5 to 9 centimeters in length with an average of 8.4 centimeters.

4. The male kalaso reaches sexual maturity at from 18.5 to 21.1 centimeters long with an average of 19.5 centimeters. The sexual maturity of the female ranges from 18.5 to 22.1 centimeters long. As to size a greater number of males appear to mature earlier than the females.

5. The banded and striped barracudas probably spawn from late in March to early in May. It is recommended that further study be made on the biology of these fishes.

6. The male banded barracuda matures at a total length of from 32.5 to 34.1 centimeters with an average of 33.3 centimeters. The female matures at from 32.5 to 34.9 centimeters long with an average of 34.2 centimeters.

7. The sexual maturity of the striped barracuda ranges from 21.5 to 23.7 centimeters long for the male and 22.1 to 23.4 centimeters for the female. The average for both sexes is about 23 centimeters long.

8. It is recommended that careful analysis of the catch of the beam trawls, which are extensively operating in Manila Bay, be made in order to standardize the mesh opening of the nets if necessary.

9. A size limit for each of the commercial fishes studied should be made. The following size limits are recommended:

Species.	Standard length.	Total length.
	cm.	*cm.*
1. Alakaak	12.0	14.5
2. Malakapas	8.5	10.5
3. Bisugong buntutan	8.5	10.5
4. Kalaso	20.5	23.0
5. Banded barracuda	28.0	34.0
6. Striped barracuda	19.0	23.0

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THE ELATERID BEETLES OF THE PHILIPPINE ISLANDS

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The last previous catalogue of the Philippine Elateridæ, or click beetles, is Schultze's (15[1]) published in 1916, in which one hundred twenty-seven species and varieties are listed. So much material, either new or from unrecorded localities, has since come to hand, that it seems timely to bring up to date our knowledge of this interesting family of insects.

A great amount of Philippine material has come to the writer for examination during the past few years. Practically all of it that was unusual or doubtful was referred by him to Mr. Edmond Fleutiaux, of Nogent-sur-Marne, France, a student whose knowledge of the Elateridæ of the world is unequaled. From this material Mr. Fleutiaux has described some fifty new species and identified numerous species not previously recorded from the Islands.

Foremost among the collectors in the Philippines who have added to a knowledge of this family is, of course, the late Prof. Charles F. Baker. A number of new elaterid species have been described from Professor Baker's captures since the Schultze catalogue appeared. An unusually large and interesting amount of material came from Mr. Fred C. Hadden during his residence for the Hawaiian Sugar Planters' Association in the Islands from 1930 to 1932. In addition to his own tireless collecting Mr. Hadden enlisted others to collect, among them Mr. H. C. Muzzall, who worked in the vicinity of Zamboanga, Mindanao, and Mr. L. H. Phillips in Bukidnon Province of the same island. The material from the Camarines Provinces of Luzon, in the Hadden collection, was collected by Mr. E. E. Schneider.

Additional contributions of value were made by the late Mr. Alonzo W. Lopez, of the Philippine Sugar Association, and by the late Dr. Fred Muir, of Honolulu. Other entomologists who contributed specimens are Dr. F. X. Williams and Mr. C. E. Pemberton, of the Hawaiian Sugar Planters' Association Ex-

[1] Numbers in parentheses refer to the appended bibliography.

periment Station, and Mr. R. C. McGregor, of the Philippine Bureau of Science, who collected most of the specimens in a collection submitted by Cornell University.

Of the two hundred four species and eleven varieties here listed, one hundred sixty-nine (about 78 per cent) are known only from the Philippines at present. The affinities of the family in the Archipelago are more Indomalayan than Australasian, a conclusion already made familiar by studies of other faunal groups. A total of thirty-nine species (about 18 per cent) are known to occur elsewhere in the Indomalayan Region, while only ten species in the Islands are common to the Australasian Region. This disparity is perhaps accentuated by the fact that much more collecting has been done in Luzon than in the southeastern islands where invasion by Australasian species might reasonably have occurred more readily. Of the one hundred fifty-four Luzon species, 16 per cent (26 species) are common to the outlying Indomalayan fauna, and 4.5 per cent (7 species) to the Australasian. Of the seventy-seven species known from Mindanao, 19 per cent (15 species) occur elsewhere in Indomalaya, and 7.7 per cent (6 species) in the Australasian Region.

Known from the Philippines only	170
Common to the Philippines and:	
The rest of the Indomalayan Region	39
Borneo and adjacent islands	24
Java	15
Sumatra and adjacent islands	15
Indo-China	12
Australasian Region	10
Celebes	7

The following list shows the total species and varieties present on each of the Philippine Islands for which there are definite records:

Babuyanes	6	Panay	7
Calayan	1	Negros	13
Camiguin	1	Cebu	3
Luzon	15	Bohol	8
Alabat	2	Leyte	3
Batan	1	Panaon	1
Mindoro	3	Palawan	17
Sibuyan	3	Balabac	12
Masbate	3	Mindanao	77
Ticao	1	Basilan	5
Samar	2	Jolo	2

This catalogue is offered in the hope of stimulating interest in this family in a region unusually rich. After more or less incidental collecting on some twenty islands of this extensive group, the Philippines proves to have an elaterid fauna eight times richer per unit area than that of the continental United States. Luzon is the only island on which adequate collecting has even been approximated; the large southern islands are probably equally rich.

Names of islands are printed in capitals and small capitals. Names following locality citations are of collectors, unless otherwise indicated. Authority for a locality, other than of a type, is indicated by an author's name accompanied by a number which refers to the bibliography. In the absence of such information, the present compiler is responsible for the identification, except that references to the Fleutiaux collection are from identifications made by Mr. Fleutiaux himself. An asterisk before a name indicates a new island record for the Philippines.

In conclusion, the generous assistance of Mr. Fleutiaux, who added numerous new records, is gratefully acknowledged by the writer who alone is responsible for any inaccuracies in the compilation.

Genus AGRYPNUS Eschscholtz

1. AGRYPNUS BIFOVEATUS Candèze.

Agrypnus bifoveatus CANDÈZE, Mon. des Elat. 1 (1857) 41.

All the islands (Candèze 2). CEBU, Toledo (Schultze 15). LUZON, Cagayan Province, Tuguegarao (Schultze 15): Camarines Sur Province, Mabatobato, Pili (Hadden, May): Laguna Province, Los Baños (Fleutiaux 4), Mount Maquiling (Hadden): Tayabas Province (Schultze 15): Manila (McGregor). *MINDANAO, Surigao Province (Cornell collection), Tambanan, Kabasalan (Muzzall, January).

This species occurs also in Guam.

2. AGRYPNUS JAVANUS Candèze.

Agrypnus javanus CANDÈZE, Mon. des Elat. 1 (1857) 44.

LUZON, Tarlac Province, Pura, Anao (Schultze 15). *MINDANAO, Bukidnon Province, Tanculan (Baker; Fleutiaux collection). TICAO (Schultze 15).

Originally described from Java; this species is known also from Sumatra and the Malay Peninsula.

3. AGRYPNUS LOPEZI Fleutiaux.

Agrypnus lopezi FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 477.

MINDANAO, Bukidnon Province, Diklom, 2,000 feet (Phillips, March) (type locality); Santa Fe, 3,000 feet (Phillips, May to August).

This species was named in memory of the late Alonzo William Lopez, entomologist of the Philippine Sugar Association.

4. AGRYPNUS MUCRONATUS Candèze.

Agrypnus mucronatus CANDÈZE, Mon. des Elat. 1 (1857) 42.

*LUZON, Laguna Province, Mount Maquiling, 400 feet (Hadden, July; Fleutiaux det.).

Originally described from Borneo; a variety occurs in Indo-China.

5. AGRYPNUS PONDERATUS Candèze.

Agrypnus ponderatus CANDÈZE, Elat. nouv., fasc. 6 (1896) 5.

MINDANAO (type locality). PALAWAN, Mount Salacot (Schultze 15).

6. AGRYPNUS ROBUSTUS Fleutiaux.

Agrypnus robustus FLEUTIAUX, Bull. Soc. ent. France (1902) 163.

CEBU, Toledo (Schultze 15).

Described from Java; known also from Ceylon, Malacca, Indo-China, and Borneo.

7. AGRYPNUS TOMENTOSUS (Fabricius).

Elater tomentosus FABRICIUS, Ent. Syst. (1798) 138.

Throughout the Archipelago (Candèze 2). *LUZON, Ambos Camarines Province, Mount Isarog (Cornell collection): Camarines Sur Province, Mabatobato, Pili (Hadden, May): Laguna Province, Mount Maquiling, 2,000 feet (Hadden, April to June; Fleutiaux det.): Nueva Vizcaya Province, Imugan (Cornell collection). PALAWAN, Iwahig (Schultze 15).

Candèze (1, 1: 41) records it at the roots of banana.

Genus LACON Laporte de Castelnau

8. LACON INCOMMODUS Fleutiaux.

Lacon incommodus FLEUTIAUX, Bull. et Ann. Soc. ent. Belg. 74 (1934) 364.

MINDANAO, Davao (Baker) (type locality).

9. LACON LUZONICUS (Candèze).

Adelocera luzonica CANDÈZE, Bull. Soc. ent. Belg. (1875) 119.

LUZON (type locality).

10. LACON MODESTUS (Boisduval).

Agrypnus modestus BOISDUVAL, Voy. Astrolabe, Coleop. (1835) 108.
Agrypnus pruinosus FAIRMAIRE.
Agrypnus squalidus FAIRMAIRE.
Agrypnus nigroplagiatus L. BLANCHARD.
Adelocera guadulpensis CANDÈZE.
Adelocera vicinus CANDÈZE.
Adelocera tessellatus CANDÈZE.

JOLO (Fleutiaux 1). LUZON (Candèze 3). MINDANAO, Davao (Fleutiaux 7).

Throughout the Tropics of the world.

11. LACON NOVUS Fleutiaux.

Lacon novus FLEUTIAUX, Bull. et Ann. Soc. ent. Belg. 54 (1934) 364.

LUZON, Tayabas Province, Mount Banahao (type locality).

12. LACON (ADELOCERA) PHILIPPINUS Fleutiaux.

Lacon (Adelocera) philippinus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 478.

MINDANAO, Zamboanga Province, Kabasalan (Muzzall, April) (type locality).

Described from a single specimen.

Genus ADELOCERA Latreille

13. ADELOCERA (COMPSOLACON) APODIXA (Candèze).

Lacon apodixus CANDÈZE, Elat. nouv., fasc. 1 (1865) 9.

CAMIGUIN (Babuyanes) (Schultze 15). LUZON (type locality), Cagayan Province, Tauit (Schultze 15). MINDANAO (Candèze 2). MINDORO, Bongabon (Schultze 15).

14. ADELOCERA (COMPSOLACON) BAKERI (Fleutiaux).

Lacon bakeri FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 219.

MINDANAO, Agusan Province, Butuan (type locality).

15. ADELOCERA (COMPSOLACON) CERVIÑA (Erichson).

Lacon cervina ERICHSON, Beitr. Zool. Meyen's Reise, Acta Leop. Car. 16 Suppl. 1 (1834) 230.

All the islands (Candèze 2). CALAYAN (Babuyanes) (Schultze 15). LUZON (type locality): Bataan Province, Lamao (Schultze 15): Laguna Province, Mount Maquiling (Fleutiaux 4): Mountain Province, Baguio (Williams, June); Mount Data, 5,000 feet (Hadden, May; Fleutiaux det.): Manila (Schultze 15). *NEGROS, Occidental Negros Province (Williams, September).

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16. ADELOCERA (COMPSOLACON) DORCINA (Candèze).

Lacon dorcina CANDÈZE, Bull. Soc. ent. Belg. (1875) 119.

BOHOL (type locality). MINDANAO, Zamboanga Province, Dapitan (Fleutiaux 5); Kabasalan (Muzzall, March): Bukidnon Province, Santa Fe (Phillips); Diklom, 2,000 to 3,000 feet (Phillips, March to May). *NEGROS, Oriental Negros Province, Dumaguete (Williams, April; Fleutiaux det.).

17. ADELOCERA (COMPSOLACON) INTERMEDIA (Schwarz).

Lacon intermedia SCHWARZ, Stett. Ent. (1902) 199.

CEBU, Toledo (Schultze 15). LUZON, Tayabas Province, Baler (Schultze 15).

Described from Sumatra and North Borneo.

18. ADELOCERA (COMPSOLACON) LOPEZI Fleutiaux.

Adelocera (Compsolacon) lopezi FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 477.

NEGROS, Occidental Negros Province, La Carlota (Lopez, June) (type locality).

19. ADELOCERA (ARCHONTAS) MACGREGORI Fleutiaux.

Adelocera (Archontas) macgregori FLEUTIAUX, Bull. et Ann. Soc. ent. Belg. 74 (1934) 364.

PANAY (McGregor) (type locality).

20. ADELOCERA (ADELOCERA) MOLITOR (Candèze).

Lacon molitor CANDÈZE, Bull. Soc. ent. Belg. (1875) 119.

MINDANAO, southwest coast (type locality): Bukidnon Province, Santa Fe, Diklom, 2,000 to 3,000 feet (Philips, March–May): Zamboanga Province, Kabasalan (Muzzall, March). PALAWAN, Iwahig, Bacuit (Schultze 15).

Found very numerous at Diklom by Phillips.

21. ADELOCERA (COMPSOLACON) SPURCA (Candèze).

Lacon spurca CANDÈZE, Elat. nouv., fasc. 1 (1865) 11.

LUZON (type locality): Mountain Province, Camp 82, 6,000 feet (Hadden, May; Fleutiaux det.); Mount Data, 5,000 feet (Hadden, May); Mount Santo Tomas, 6,000 feet (Hadden, May): Tayabas Province, Malinao (Fleutiaux 5).

22. ADELOCERA (COMPSOLACON) SUBCERVINA (Fleutiaux).

Lacon subcervina FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 219.

LUZON, Bataan Province, Mount Limay (type locality): Pangasinan Province, Asingan (Hadden, May; Fleutiaux det.).

Genus MERISTHUS Candèze

23. **MERISTHUS NIGRITULUS Candèze.**

Meristhus nigritulus CANDÈZE, Elat. nouv., fasc. 5 (1893) 10.

LUZON, Laguna Province, Los Baños (Fleutiaux 4).
Originally described from Sumatra.

Genus BRACHYLACON Motschulsky

24. **BRACHYLACON MICROCEPHALUS Motschulsky.**

Brachylacon microcephalus MOTSCHULSKY, Etud. Ent. 7 (1858) 60.
Lacon trifasciatus CANDÈZE.
Lacon difficilis LEWIS.

LUZON, Laguna Province, Los Baños (Schultze 15); Mount Maquiling (Fleutiaux 5). MINDANAO, Agusan Province, Butuan (Fleutiaux 5). PALAWAN (Fleutiaux 7).

This species was originally described from Ceylon and is known to range throughout the Indomalayan Region to southern Japan.

Hadden took this beetle in great numbers on Mount Maquiling, at 400 to 2,000 feet, in June, under dead bark. There also he took a specimen from "bolon" (*Alphonsea arborea*) in November, and others in June and July on the flowers of "sakat" (*Terminalia nitens*) and of "molave" (*Vitex parviflora*). Among the Mount Maquiling specimens are several considerably smaller than the typical forms, but despite their size Fleutiaux considers them the same species.

25. **BRACHYLACON OBLONGUS Fleutiaux.**

Brachylacon oblongus FLEUTIAUX, Bull. et Ann. Soc. ent. Belg. 74 (1934) 365.

LUZON, Manila (type locality).

Genus TRACHYLACON Motschulsky

26. **TRACHYLACON BAKERI Fleutiaux.**

Trachylacon bakeri FLEUTIAUX, Ann. Soc. ent. France (1935) 14.

LUZON, Nueva Vizcaya Province, Imugan (type locality) (Baker).

26. 1. **TRACHYLACON LUZONICUS Fleutiaux.**

Trachylacon luzonicus FLEUTIAUX, Ann. Soc. ent. France (1935) 17.

LUZON, Tayabas Province, Mount Banahao.

Genus AGRAEUS Candèze

27. **AGRAEUS MANNERHEIMI Candèze.**

Agraeus mannerheimi CANDÈZE, Mon. des Elat. 1 (1857) 166, pl. 3, fig. 4.
Agraeus ritsemae CANDÈZE (male).

*LUZON, Laguna Province, Mount Maquiling, 400 feet (Hadden, June; Fleutiaux det.). * NEGROS, Oriental Negros Province, Cuernos Mountains (Baker; Fleutiaux collection).

Hitherto known only from Java and Sumatra.

Genus ALAUS Eschscholtz

28. ALAUS BREVIPENNIS Candèze.

Alaus brevipennis CANDÈZE, Bull. Soc. ent. Belg. (1875) 120.

BABUYANES (type locality). BOHOL (type locality). LUZON (eastern) (type locality): Tayabas Province, Mount Banahao (Cornell collection). MINDANAO (Schultze 15), Bukidnon Province, Santa Fe, 2,000 feet (Phillips, June): Zamboanga Province, Tambanan (Muzzall, June; Fleutiaux det.).

29. ALAUS FARINULENTUS Fleutiaux.

Alaus farinulentus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 478.

LUZON, Mountain Province, Mount Data, 5,000 feet (Hadden, May); Mount Santo Tomas, 6,000 feet (Hadden, May) (both type localities).

30. ALAUS LACTEUS (Fabricius).

Elater lacteus FABRICIUS, Syst. El. 2 (1801) 230.

*LUZON, Laguna Province, Pangil (Hadden, May). MINDANAO (Candèze 2).

Originally known from Borneo and Sumatra. The variety mentioned by Candèze (2: p. 120) from Mindanao is *pantherinus* Candèze, in Fleutiaux's opinion.

ALAUS MODIGLIANI Candèze.

Alaus modigliani CANDÈZE, Ann. Mus. Genova II 12 (1892) 797.

Schultze (15) records from Sibuyan this species, which is otherwise known only from Engano Island, south of Sumatra. Its presence in the Philippines is doubtful.

31. ALAUS NEBULOSUS Candèze.

Alaus nebulosus CANDÈZE, Mon. des Elat. 1 (1857) 232.

BOHOL (Schultze 15). LEYTE (Schultze 15). LUZON, Camarines Sur Province, Iriga (Hadden, June): Laguna Province, Los Baños (Hadden, October); Mount Maquiling, bred from wood of *Ficus minahassæ* and of *Artocarpus blancoi* (Hadden, February, July, November, and December); Pangil (Hadden, May to July): Mountain Province, Mount Polis, Ifugao, 3,000 feet (Hadden, July): Nueva Vizcaya Province, Imugan (Cornell collection): Manila (type locality): Tayabas Province, Mount Banahao (Fleutiaux 5). * MASBATE, Aroroy (Cornell collec-

tion). MINDANAO (Candèze 2), Bukidnon Province, Diklom, 3,000 feet (Phillips, March): Surigao Province (Cornell collection).

Apparently a rather common species on Luzon.

32. ALAUS PANTHERINUS Candèze.

Alaus pantherinus CANDÈZE, Elat. nouv., fasc. 3 (1881) 16.

*LUZON, Tayabas Province, Mount Banahao (Baker; Fleutiaux collection). MINDANAO (type locality). * PALAWAN (Waterstradt; Fleutiaux collection).

33. ALAUS PODARGUS Candèze.

Alaus podargus CANDÈZE, Rev. des Elat. (1874) 125.

BOHOL (Candèze 2). LUZON (type locality), Ambos Camarines Province, Mount Isarog (Fleutiaux collection): Laguna Province, Mount Maquiling (Fleutiaux collection); Pangil (Hadden, May): Tayabas Province, Quezon Park (Hadden). *MASBATE, Aroroy (Fleutiaux collection). * MINDANAO, Agusan Province, Santiago (Phillips, April; Fleutiaux det.).

What is probably this same species is in the Fleutiaux collection from Sibuyan Island (Baker).

34. ALAUS SCYTALE Candèze.

Alaus scytale CANDÈZE, Mon. des Elat. 1 (1857) 228.

LUZON (Candèze 2), Laguna Province, Los Baños, from shallow boring in dead twig of *Ficus indica* (Williams, April); Mount Maquiling, on flowers of "molave" (*Vitex parviflora*) (Hadden, July); San Antonio (Schultze 15): Tayabas Province, Quezon Park (Hadden, May). *MINDANAO, Bukidnon Province, Diklom, 3,000 feet (Phillips, March; Fleutiaux det.); Santa Fe 2,000 feet (Phillips, June).

Known also from Celebes and New Guinea.

35. ALAUS SEMPERI Candèze.

Alaus semperi CANDÈZE, Ann. Soc. ent. Belg. (1875) 120.

MINDANAO, east coast (type locality): Bukidnon Province, Santa Fe, 2,000 feet (Phillips, June). *SAMAR (*Baker 20967, 23148;* Fleutiaux collection).

36. ALAUS SUPERBUS Candèze.

Alaus superbus CANDÈZE, Ann. Soc. ent. Belg. (1875) 120.

*LUZON, Bataan Province, Mount Limay (Baker; Fleutiaux collection): Nueva Vizcaya Province, Imugan (Fleutiaux collection). MINDANAO, east coast (type locality).

Genus EUMOEUS Candèze

37. **EUMOEUS BAKERI** (Fleutiaux).

Tharopsides bakeri FLEUTIAUX, Bull. Mus. Paris (1818) 236, footnote.

*LUZON, Laguna Province, Mount Maquiling (Hadden, May; Fleutiaux det.). MINDANAO, Zamboanga (Baker) (type locality).

The change of generic name is by Fleutiaux, in correspondence.

Genus EUMOEUS Candèze

38. **TETRIGUS FLABELLATUS** (Germar).

Aphanobius flabellatus GERMAR, Zeit. Ent. 5 (1844) 186.

*LUZON, Laguna Province, Mount Maquiling (Hadden, June; Fleutiaux det.).

Described from Java.

Genus CAMPSOSTERNUS Latreille

39. **CAMPSOSTERNUS ESCHSCHOLTZI** Hope.

Campsosternus eschscholtzi HOPE, Trans. Ent. Soc. London 3 (1843) 292.

LUZON, Manila (type locality).

Some of the earlier references to "Manila," this one possibly included, are undependable; the name was sometimes used loosely for the entire Archipelago.

40. **CAMPSOSTERNUS PROTEUS** Hope.

Campsosternus proteus HOPE, Trans. Ent. Soc. London 3 (1843) 291.

LUZON, Manila (type locality) (Schultze 15).

41. **CAMPSOSTERNUS RUTILANS** Chevrolat.

Campsosternus rutilans CHEVROLAT, Rev. Zool. (1841) 22.

LUZON, Laguna Province, Agricultural College (Hadden, June); Mount Maquiling, 400 feet (Hadden, May).

Known also from the Sunda Islands; apparently common in the Mount Maquiling region.

41a. **CAMPSOSTERNUS RUTILANS** var. **SUMPTUOSUS** Hope.

Campsosternus rutilans var. *sumptuosus* HOPE, Trans. Ent. Soc. London 3 (1843) 228.

LUZON, Bataan Province, Lamao (Schultze 15): Manila (type locality). *MINDANAO, Bukidnon Province, Santa Fe, 2,000 feet (Phillips, June; Fleutiaux det.). PALAWAN, Iwahig (Schultze 15).

This variety is doubtfully present in Java.

41b. CAMPSOSTERNUS RUTILANS Chevrolat var.

LUZON, Rizal Province, Novaliches (Hadden, May; Fleutiaux det.).

This variety is blackish.

Genus OXYNOPTERUS Hope

42. OXYNOPTERUS AUDOUINI Hope.

Oxynopterus audouini HOPE, Proc. Zool. Soc. London (1842) 77.

LUZON, Laguna Province, Los Baños (Schultze 15); Mount Maquiling (Hadden): Manila (Schultze 15): Rizal Province, Novaliches (Hadden): Tayabas Province, Mount Banahao (Fleutiaux 5); Quezon Park (Hadden). PALAWAN, Iwahig (Schultze 15).

Hadden took this beetle in flight in the late afternoon on Mount Maquiling, and at lights at night. Of twenty-three specimens so taken in January, March to August, and November at Novaliches, Quezon Park, Los Baños, and Mount Maquiling, all but two are males.

I am indebted to Mr. Fleutiaux for the following synonymy distribution of the species of this genus:

Oxynopterus mucronatus Olivier (*flabellicornis* Castelnau; *javanus* Hope); Java.
Oxynopterus audouini Hope (*cumingi* Hope); Philippines.
Oxynopterus candezei Fleutiaux (*audouini* Candèze, nec Hope); Penang; Sumatra.
Oxynopterus harmandi Fleutiaux; Cochin China; Laos.
Oxynopterus harmseni Candèze; Sumatra.
Oxynopterus annamensis Fleutiaux; Annam.

Genus PROPSEPHUS Hyslop

43. PROPSEPHUS INCAUTUS (Candèze).

Psephus incautus CANDÈZE, Elat. nouv., fasc. 6 (1896) 26.

BALABAC (type locality).

44. PROPSEPHUS ORIENTALIS (Candèze).

Psephus orientalis CANDÈZE, Elat. nouv., fasc. 7 (1900) 7.

Philippine Islands (type locality).

45. PROPSEPHUS PHILIPPINENSIS (Candèze).

Psephus philippinensis CANDÈZE, Bull. Soc. ent. Belg. (1875) 121.

BOHOL (type locality).

Genus SPHENOMERUS Candèze

46. SPHENOMERUS BAKERI (Fleutiaux).

Dicronychus bakeri FLEUTIAUX, Philip. Journ. Sci. § D 9 (1914) 449.

LUZON, Laguna Province, Mount Maquiling (type locality).

A specimen in the Hadden collection was taken on Mount Maquiling at 400 feet in October, and another in August. The generic synonymy is Fleutiaux's, in correspondence.

Genus SIMODACTYLUS Candèze

47. **SIMODACTYLUS CINNAMOMEUS (Boisduval).**

Aeolus cinnamomeus BOISDUVAL, Faune Oceanie, Coleop. (1835) 106.

? MINDANAO.

Candèze (2) mentions a single specimen taken in the Philippines by Semper, most of whose collecting was in Mindanao. The species is widespread throughout Oceania.

48. **SIMODACTYLUS LUZONICUS Fleutiaux.**

Simodactylus luzonicus FLEUTIAUX, Bull. et Ann. Soc. ent. Belg. 74 (1934) 365.

LUZON, Tayabas Province, Mount Banahao (type locality).

49. **SIMODACTYLUS PHILIPPINENSIS Fleutiaux.**

Simodactylus philippinensis FLEUTIAUX, Bull. et Ann. Soc. ent. Belg. 74 (1934) 366.

MINDANAO, Surigao Province (Baker) (type locality).

50. **SIMODACTYLUS PULCHERRIMUS Candèze.**

Simodactylus pulcherrimus CANDÈZE, Elat. nouv., fasc. 4 (1889) 89.

LUZON, Tayabas Province (type locality).

SIMODACTYLUS TASMANI Candèze.

Simodactylus tasmani CANDÈZE, Elat. nouv., fasc. 5 (1893) 24.

Fleutiaux doubtfully identifies as this species a specimen taken in Occidental Negros (Williams, September). The species was described from the Fiji Islands.

Genus MONOCREPIDIUS Eschscholtz

51. **MONOCREPIDIUS PHILIPPINENSIS Fleutiaux.**

Monocrepidius philippinensis FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 221.

LUZON, Tayabas Province, Mount Banahao (type locality).

Whether or not *Monocrepidius* should be reduced to a subgenus under *Conoderus* is perhaps a matter of individual opinion.

52. **MONOCREPIDIUS HADDENI Fleutiaux.**

Monocrepidius haddeni FLEUTIAUX, Philip. Journ. Sci. 49 (1932) 567.

LUZON, Laguna Province (Hadden) (type locality).

Genus HETERODERES Latreille

53. HETERODERES MALAISIANUS Candèze.

Heteroderes malaisianus CANDÈZE, Mon. des Elat. 2 (1859) 359.

*MINDANAO, Zamboanga Province, Kabasalan (Muzzall, May and June; Fleutiaux det.).

Originally described from Java; this insect occurs throughout the Malay Archipelago eastward as far as Timor.

54. HETERODERES PALLIDUS Fleutiaux.

Heteroderes pallidus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 478.

LUZON, Laguna Province, Los Baños (Muir) (type locality).

Described from a single specimen.

55. HETERODERES PROSTERNALIS (Candèze).

Drasterius prosternalis CANDÈZE, Elat. nouv., fasc. 2 (1878) 26.
Heteroderes drasteroides FLEUTIAUX.

LUZON, Laguna Province, Los Baños (Fleutiaux 4).

Originally described from India; it is known also from Burma, Indo-China, Java, Sumatra, Borneo, and China.

56. HETERODERES TRIANGULARIS (Eschscholtz).

Elater triangularis ESCHSCHOLTZ, Entomogr. 1 (1822) 73.

LUZON, Laguna Province, Los Baños (Muir): Manila, light trap (Hadden, June). *NEGROS, Occidental Negros Province, La Carlota (Lopez; Fleutiaux det.).

Originally described from the Philippines; this species has a wide range throughout the Malay Archipelago and Indo-China.

Genus AEOLODERMA Fleutiaux

57. AEOLODERMA BRACHMANA (Candèze).

Aeolus brachmana CANDÈZE, Mon. des Elat. 2 (1859) 345.
Heteroderes multilineatus CANDÈZE.
Heteroderes beccarii CANDÈZE.

LEYTE, Tacloban (Fleutiaux 5). LUZON, Laguna Province, Los Baños (Fleutiaux 4); Mount Maquiling (Hadden, August): Manila (Schultze 15): Rizal Province, Montalban (Schultze 15).

Occurs from Ceylon to Formosa. The synonymy is according to Fleutiaux [Ann. Soc. ent. France (1905) 21, and Faune ent. de l'Indochine, No. 2 (June, 1924) Elateridæ 75], who considers *beccarii* and *multilineatus* to be only local races of this extremely variable species.

58. AEOLODERMA MINUSCULUS (Candèze).

Heteroderes minusculus CANDÈZE, Elat. nouv., fasc. 2 (1878) 23.

Philippine Islands (type locality).

Genus PRODRASTERIUS Fleutiaux

59. **PRODRASTERIUS INSULARIS** (Candèze).

Drasterius insularis CANDÈZE, Bull. Soc. ent. Belg. (1875) 121.

BOHOL (type locality).

60. **PRODRASTERIUS SULCATULUS** (Candèze).

Drasterius sulcatulus CANDÈZE, Mon. des Elat. 2 (1859) 427.

LUZON, Laguna Province, Los Baños (Fleutiaux 4): Manila (Fleutiaux collection).

The type locality is East Indies; known also from Sumatra and India.

Genus ELATER Linnæus

61. **ELATER CONSPURCATUS** Candèze.

Elater conspurcatus CANDÈZE, Elat. nouv., fasc. 4 (1889) 34.
Megapenthes cinctus FLEUTIAUX.

LUZON, Laguna Province, Mount Maquiling, 400 feet (Hadden, June; Fleutiaux det.): Tayabas Province, Dolores (type locality).

Genus MEGAPENTHES Kiesenwetter

62. **MEGAPENTHES ANGULOSUS** Candèze.

Megapenthes angulosus CANDÈZE, Bull. Soc. ent. Belg. (1875) 122.

LUZON, Laguna Province, Los Baños (Williams, June and July; Fleutiaux det.). MINDANAO (type locality).

63. **MEGAPENTHES ANGUSTUS** Fleutiaux.

Megapenthes angustus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1932) 48.

Luzon, Laguna Province, Mount Maquiling (Hadden, April and May) (type locality).

Hadden also took this beetle on Mount Maquiling at 400 feet in June and July, and at 3,000 feet on flowers of "santan puti" (*Ixora finlaysoniana*) in July.

64. **MEGAPENTHES BAKERI** Fleutiaux.

Megapenthes bakeri FLEUTIAUX, Bull. et Ann. Soc. ent. Belg. 74 (1934) 368.

MINDANAO, Lanao Province, Kolambugan. SAMAR (Baker) (type locality).

MEGAPENTHES CINCTUS Fleutiaux.

Megapenthes cinctus FLEUTIAUX, Philip. Journ. Sci. 49 (1932) 567.

Referred to *Elater conspurcatus* Candèze by Fleutiaux, Bull. Soc. ent. France 38 (1933) 114.

65. MEGAPENTHES CONGESTUS Candèze.

Megapenthes congestus CANDÈZE, Elat. nouv., fasc. 6 (1896) 42.

BALABAC (type locality).

66. MEGAPENTHES DIPLOCONOIDES Candèze.

Megapenthes diploconoides CANDÈZE, Bull. Soc. ent. Belg. (1875) 122.

Philippine Islands (type locality); possibly Mindanao.

67. MEGAPENTHES FRONTALIS Fleutiaux.

Megapenthes frontalis FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1932) 47.

LUZON, Laguna Province, Los Baños (Pemberton, March to June); Mount Maquiling, 2,000 feet (Hadden, April) (type locality); Pangil (Hadden, May): Mountain Province, Baguio (Williams, June).

68. MEGAPENTHES FULVUS Fleutiaux.

Megapenthes fulvus FLEUTIAUX, Philip. Journ. Sci. § D 9 (1914) 443.

LUZON, Ambos Camarines Province, Mount Isarog (Cornell collection): Laguna Province, Los Baños and Mount Maquiling, 2,000 feet (Hadden, June) (type localities); Pangil (Hadden, May): Nueva Vizcaya Province, Imugan (Cornell collection): Tayabas Province, Mount Banahao (Cornell collection). *MINDANAO, Bukidnon Province, Diklom, 3,000 feet (Phillips, April): Zamboanga Province, Kabasalan (Muzzall, April; Fleutiaux det.).

69. MEGAPENTHES HADDENI Fleutiaux.

Megapenthes haddeni FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 481.

LUZON, Laguna Province, Mount Maquiling (Hadden, April) (type locality): Tayabas Province, Mount Banahao (Cornell collection).

70. MEGAPENTHES INCONDITUS Candèze.

Megapenthes inconditus CANDÈZE, Bull. Soc. ent. Belg. (1875) 122.

All the islands (Candèze 2). LUZON, Laguna Province, Los Baños (Fleutiaux 4); Mount Maquiling (Fleutiaux 5): Tayabas Province, Malinao and Mount Banahao (Fleutiaux 5). PALAWAN, Puerto Princesa (Fleutiaux 5).

Apparently common on Mount Maquiling throughout the year. Known also from Celebes.

71. **MEGAPENTHES INFLATUS Candèze.**

Megapenthes inflatus CANDÈZE, Bull. Soc. ent. Belg. (1875) 122.

Babuyanes (type locality). LUZON, Ambos Camarines Province, Mount Isarog (Cornell collection): Laguna Province, Los Baños (Pemberton, March to June); Mount Maquiling, on flowers of *Terminalia nitens* and of *Vitex parviflora* (Hadden, June); Pangil (Hadden, May): Manila (Cornell collection): Tayabas Province, Mount Banahao (Fleutiaux 5). *MINDANAO, Bukidnon Province, Diklom, 3,000 feet (Phillips, April).

72. **MEGAPENTHES JUNCEUS Candèze.**

Megapenthes junceus CANDÈZE, Elat. nouv., fasc. 1 (1865) 30.

LUZON, Camarines Sur Province, Iriga (Hadden collection, July): Laguna Province, Mount Maquiling, 2,000 to 3,000 feet, on flowers of *Clethra lancifolia* (Hadden, April to June): Manila (type locality): Tayabas Province, Mount Banahao (Fleutiaux 5). MINDANAO, Agusan Province, Butuan (Fleutiaux 5): Bukidnon Province, Diklom, 3,000 feet (Phillips, March): Surigao Province (Cornell collection).

This species is known also from Borneo, Java, and Burma.

72a. **MEGAPENTHES JUNCEUS var. CANDÈZEI Fleutiaux.**

Megapenthes junceus var. *candèzei* FLEUTIAUX, Philip. Journ. Sci. § D 9 (1914) 442.

LUZON, Laguna Province, Mount Maquiling (type locality).

73. **MEGAPENTHES LEWISI Fleutiaux.**

Glyphonyx ornatus FLEUTIAUX, Philip. Journ. Sci. § D 9 (1916) 233; not *Megapenthes ornatus* Lewis, 1894.

LUZON, Laguna Province, Mount Maquiling: Tayabas Province, Mount Banahao (type localities).

The change in generic name was made by Fleutiaux in correspondence; the Japanese *Megapenthes ornatus* Lewis, 1894, has priority.

MEGAPENTHES LIGATUS (Candèze).

Melanoxanthus ligatus CANDÈZE, Ann. Mus. Genova (1878) 124.

Fleutiaux (9, part 2, p. 166) records specimens from the Philippines that are very close to the typical form from Borneo.

74. **MEGAPENTHES LUZONICUS Fleutiaux.**

Megapenthes luzonicus FLEUTIAUX, Philip. Journ. Sci. § D 9 (1914) 442.

LUZON, Laguna Province, Los Baños (Schultze 15); Mount Maquiling (type locality): Tayabas Province, Mount Banahao (Fleutiaux 5).

75. MEGAPENTHES MACERATUS Candèze.

Megapenthes maceratus CANDÈZE, Elat. nouv., fasc. 6 (1896) 42.

BALABAC (type locality). * MINDANAO, Bukidnon Province, Diklom, 3,000 feet (Phillips, March; Fleutiaux det.).

76. MEGAPENTHES MAGNUS Fleutiaux.

Megapenthes magnus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 482.

LUZON, Mountain Province, Camp 82, 6,000 feet (Hadden, May) (type locality).

Described from a single specimen.

77. MEGAPENTHES NIGRICORNIS Candèze.

Megapenthes nigricornis CANDÈZE, Bull. Soc. ent. Belg. (1875) 123.

LUZON (type locality).

78. MEGAPENTHES OPACIPENNIS Candèze.

Megapenthes opacipennis CANDÈZE, Bull. Soc. ent. Belg. (1875) 122.

* LUZON, Mountain Province, Mount Santo Tomas, 6,000 feet (Hadden, May; Fleutiaux det.).

No locality was named for Candèze's material; Hadden's taking of this species appears to be the first since it was described.

79. MEGAPENTHES ORNATICOLLIS Fleutiaux.

Megapenthes ornaticollis FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 481.

MINDANAO, Bukidnon Province, Diklom, 3,000 feet (Phillips, March) (type locality).

Described from a single specimen.

80. MEGAPENTHES PHILIPPINENSIS Fleutiaux.

Megapenthes philippinensis FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1932) 48.

LUZON, Laguna Province, Mount Maquiling, 3,000 feet, on flowers of "malaklak" (*Clethra lancifolia*) (Hadden, April) (type locality).

Genus MELANOXANTHUS Eschscholtz

81. MELANOXANTHUS ACUTIFRONS Fleutiaux.

Melanoxanthus acutifrons FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 480.

LUZON, Laguna Province, Mount Maquiling, 2,000 feet (Hadden, June) (Ladrera, March) (type locality).

82. MELANOXANTHUS AFFINIS Fleutiaux.

Melanoxanthus affinis FLEUTIAUX, Philip. Journ. Sci. § D **9** (1914) 444.

LUZON, Laguna Province, Mount Maquiling, 400 feet on flowers of *Clethra lancifolia,* 3,000 feet on flowers of *Ixora finlaysoniana* (Hadden, July) (type locality): Tayabas Province, Mount Banahao (Feutiaux 5). MINDANAO, Agusan Province, Butuan (Fleutiaux 5).

83. MELANOXANTHUS APPROXIMATUS Candèze.

Melanoxanthus approximatus CANDÈZE, Bull. Soc. ent. Belg. (1875) 123.

ALABAT (type locality). LUZON, Laguna Province, Los Baños (Schultze 15); Mount Maquiling (Fleutiaux 5): Tayabas Province, Quezon Park (Hadden, May).

84. MELANOXANTHUS ATER Fleutiaux.

Melanoxanthus ater FLEUTIAUX, Philip. Journ. Sci. § D **9** (1914) 445.

LUZON, Laguna Province, Los Baños (type locality); Mount Maquiling, up to 3,000 feet, on flowers of *Terminalia nitens,* of *Vitex parviflora,* and of *Ehretia philippinensis* (Hadden, May and June): Tayabas Province, Mount Banahao (Fleutiaux 5).

85. MELANOXANTHUS BAKERI Fleutiaux.

Melanoxanthus bakeri FLEUTIAUX, Philip. Journ. Sci. § D **9** (1914) 443.

LUZON, Laguna Province, Agricultural College (Williams and Pemberton, June); Los Baños (type locality); Mount Maquiling, up to 3,000 feet (Hadden, May); Pangil (Hadden, May): Tayabas Province, Mount Banahao (Cornell collection).

A fairly common species in Laguna on flowers of "sakat" (*Terminalia nitens*) and of *Ehretia philippinensis.*

86. MELANOXANTHUS BASALIS Fleutiaux.

Melanoxanthus basalis FLEUTIAUX, Proc. Haw. Ent. Soc. **8** (1934) 479.

LUZON, Laguna Province, Mount Maquiling (Hadden, May) (type locality).

Described from a single specimen.

87. MELANOXANTHUS BICINCTUS Fleutiaux.

Melanoxanthus bicinctus FLEUTIAUX, Philip. Journ. Sci. § D **11** (1916) 226.

NEGROS, Cuernos Mountains (type locality).

88. MELANOXANTHUS BILINEATUS Fleutiaux.

Melanoxanthus bilineatus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 480.

LUZON, Laguna Province, Mount Maquiling (Hadden, March and June) (type locality).

89. MELANOXANTHUS BIPARTITUS Candèze.

Melanoxanthus bipartitus CANDÈZE, Bull. Soc. ent. Belg. (1875) 123.

* MASBATE, Aroroy (Cornell collection). MINDANAO (type locality), Surigao Province (Cornell collection).

90. MELANOXANTHUS BITRIPLEX Candèze.

Melanoxanthus bitriplex CANDÈZE, Elat. nouv., fasc. 6 (1896) 43.

LUZON, Laguna Province, Mount Maquiling, on flowers of *Terminalia nitens* (Hadden, June; Fleutiaux det.): Tayabas Province, Malinao (Fleutiaux 5). MINDANAO, Agusan Province, Butuan (Fleutiaux 5): Zamboanga Province, Kabasalan, on flowers (Muzzall), August).

Originally described from Banguey, a small island north of Borneo; it is known also from Borneo, Celebes, and Sumatra.

91. MELANOXANTHUS BUTUANUS Fleutiaux.

Melanoxanthus butuanus FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 226.

MINDANAO, Agusan Province, Butuan (type locality).

92. MELANOXANTHUS CINCTUS Fleutiaux.

Melanoxanthus cinctus FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 224.

LUZON, Laguna Province, Mount Maquiling (type locality); Pangil (Hadden, May): Mountain Province, Baguio ("Bacio") (Cornell collection): Nueva Vizcaya Province, Imugan (Cornell collection): Tayabas Province, Mount Banahao (type locality).

Hadden took this species at lower elevations on Mount Maquiling in June on flowers of "sakat," and higher, at 3,000 feet, in July on flowers of "santan puti" and of "molave;" in November on flowers of "kosibeng" (*Sapindus saponaria*).

93. MELANOXANTHUS COMES Candèze.

Melanoxanthus comes CANDÈZE, Elat. nouv., fasc. 6 (1896) 43.

BALABAC (type locality).

94. MELANOXANTHUS CRUCIFER Fleutiaux.

Melanoxanthus crucifer FLEUTIAUX, Philip. Journ. Sci. § D 9 (1914) 445.

LUZON, Laguna Province, Los Baños (type locality); Mount Maquiling (Hadden, June). MINDANAO, Agusan Province

(Fleutiaux 5): Lanao Province, Iligan (Fleutiaux 5). PALAWAN, Puerto Princesa (Fleutiaux 5).

95. MELANOXANTHUS DECEMGUTTATUS Candèze.

Melanoxanthus decemguttatus CANDÈZE, Bull. Soc. ent. Belg. (1875) 124.

MINDANAO (type locality).

96. MELANOXANTHUS EXCLAMATIONIS Candèze.

Melanoxanthus exclamationis CANDÈZE, Bull. Soc. ent. Belg. (1875) 123.

LUZON (type locality), Laguna Province, Agricultural College (Hadden, June); Mount Maquiling, up to 2,000 feet on flowers of *Terminalia nitens,* of *Ehretia philippinensis,* and of *Vitex parviflora* (Hadden, May to July): Tayabas Province, Mount Banahao (Cornell collection).

97. MELANOXANTHUS FINITIMUS Fleutiaux.

Melanoxanthus finitimus FLEUTIAUX, Philip. Journ. Sci. **49** (1932) 566.

LUZON, Laguna Province, Mount Maquiling (Hadden, January) (type locality).

Besides the type, Hadden took a small series at 2,000 feet on Mount Maquiling in June and July, on flowers of *Terminalia nitens* and of *Vitex parviflora.*

98. MELANOXANTHUS GRANDIS Fleutiaux.

Melanoxanthus grandis FLEUTIAUX, Bull. et Ann. Soc. ent. Belg. **74** (1934) 367.

LUZON, Mountain Province, Baguio ("Bacio") (type locality).

99. MELANOXANTHUS HADDENI Fleutiaux.

Melanoxanthus haddeni FLEUTIAUX, Philip. Journ. Sci. **49** (1932) 565.

LUZON, Laguna Province, Mount Maquiling (Hadden, May) (type locality).

100. MELANOXANTHUS HEMIONUS Candèze.

Melanoxanthus hemionus CANDÈZE, Elat. nouv., fasc. 5 (1893) 38.

LUZON, Laguna Province, Calauang (Schultze 15); Los Baños (Schultze 15); Paete (Fleutiaux 5). MINDANAO (type locality). MINDORO, Baco River (Schultze 15).

Both Candèze and Fleutiaux consider that the Philippine records of *M. zebra* (Wiedemann), a Javan species, refer to this insect. Accordingly, I have included under *hemionus* all of Schultze's records of *zebra.*

101. MELANOXANTHUS ILLUSTRIS Fleutiaux.

Melanoxanthus illustris FLEUTIAUX, Philip. Journ. Sci. **18** (1921) 73.

MINDANAO, Davao Province (Baker) (type locality).

102. MELANOXANTHUS INFIMUS Candèze.

Melanoxanthus infimus CANDÈZE, Bull. Soc. ent. Belg. (1875) 124.

LUZON, Laguna Province, Los Baños (Fleutiaux 4). MINDANAO (type locality).

103. MELANOXANTHUS INFUSCATUS Fleutiaux.

Melanoxanthus infuscatus FLEUTIAUX, Philip. Journ. Sci. § D **11** (1916) 225.

LUZON, Laguna Province, Los Baños (type locality); Mount Maquiling, 3,000 feet (Hadden, March and April; Fleutiaux det.).

104. MELANOXANTHUS INSIGNIS Fleutiaux.

Melanoxanthus insignis FLEUTIAUX, Philip. Journ. Sci. **18** (1921) 73.

MINDANAO, Davao Province (Baker) (type locality).

105. MELANOXANTHUS LATERALIS Fleutiaux.

Melanoxanthus lateralis FLEUTIAUX, Philip. Journ. Sci. **49** (1932) 566.

LUZON, Mountain Province, Baguio, 5,000 feet (Hadden, March) (type locality).

106. MELANOXANTHUS LONGICOLLIS Fleutiaux.

Melanoxanthus longicollis FLEUTIAUX, Proc. Haw. Ent. Soc. **8** (1934) 479.

MINDANAO, Bukidnon Province, Diklom, 2,000 feet (Phillips, March) (type locality).

Described from a single specimen.

107. MELANOXANTHUS LUZONICUS Fleutiaux.

Melanoxanthus luzonicus FLEUTIAUX, Philip. Journ. Sci. § D **9** (1914) 444.

LUZON, Laguna Province, Los Baños (type locality), Mount Maquiling (Schultze 15).

108. MELANOXANTHUS MELANOCEPHALUS (Fabricius).

Elater melanocephalus FABRICIUS, Spec. Ins. **1** (1781) 272.

Listed from the Philippines by Candèze (2) without specific locality. BASILAN (Schultze 15). LUZON, Laguna Province, Mount Maquiling (Hadden, August): MANILA (Schultze 15). NEGROS, Occidental Negros Province, Maao (Schultze 15).

Widely distributed throughout the Tropics. I have seen a specimen from Sarawak in the collection of Mr. J. E. A. Lewis, of Kobe, Japan.

MELANOXANTHUS MILITARIS Fleutiaux.

Melanoxanthus militaris FLEUTIAUX, Philip. Journn. Sci. § D 11 (1916) 223.

See *Anchastus fischeri* nom. nov.

109. MELANOXANTHUS MINUTUS Candèze.

Melanoxanthus minutus CANDÈZE, Elat. nouv., fasc. 6 (1896) 44.

BALABAC (Schultze 15).

Originally described from Banguey, north of Borneo.

110. MELANOXANTHUS NITIDICOLLIS Fleutiaux.

Melanoxanthus nitidicollis FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 223.

LUZON, Tayabas Province, Mount Banahao (type locality).

111. MELANOXANTHUS ORNATUS Fleutiaux.

Melanoxanthus ornatus FLEUTIAUX, Bull. et Ann. Soc. ent. Belg. 74 (1934) 367.

LUZON, Bataan Province, Mount Limay (Cornell collection): Nueva Vizcaya Province, Imugan (Cornell collection): Tayabas Province, Mount Banahao. MINDANAO, Davao. SIBUYAN (Baker). (All of the foregoing are type localities.)

112. MELANOXANTHUS PALLIATUS Candèze.

Melanoxanthus palliatus CANDÈZE, Ann. Mus. Genova II 12 (1892) 799.

LUZON (Schultze), Mountain Province, Baguio, 5,000 feet (Hadden, March; Fleutiaux det.).

Described from Engano, an island south of Sumatra.

113. MELANOXANTHUS PARVULUS Fleutiaux.

Melanoxanthus parvulus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 480.

LUZON, Laguna Province, Mount Maquiling (Hadden, April) (type locality).

Taken in large numbers in April at 3,000 feet on Mount Maquiling on flowers of *Clethra lancifolia* and of *Eugenia* sp.; a few were taken in July at the same locality on "santan puti" (*Ixora finlaysoniana*).

114. MELANOXANTHUS PHILIPPINENSIS Fleutiaux.

Melanoxanthus philippinensis FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 223.

LUZON, Tayabas Province, Mount Banahao. MINDANAO, Agusan Province, Butuan (type localities).

115. MELANOXANTHUS PROMECUS Candèze.

Melanoxanthus promecus CANDÈZE, Elat. nouv., fasc. 1 (1865) 36.

LUZON, Laguna Province, Mount Maquiling (Hadden, April to June): Nueva Vizcaya Province, Imugan (Cornell collection): Manila (type locality): Tayabas Province, Quezon Park (Hadden, April to June).

115a. MELANOXANTHUS PROMECUS Candèeze var.

LUZON, Ambos Camarines Province, Mount Isarog (Cornell collection): Mountain Province, Mount Data, 5,000 feet (Hadden, March): Nueva Vizcaya Province, Imugan (Cornell collection).

A specimen from Mount Data, seen by Fleutiaux, and considered by him to be a variety of *promecus*, has the pronotum entirely red without median black maculation; similar specimens are in the Cornell collection.

116. MELANOXANTHUS RECREATUS Candèze.

Melanoxanthus recreatus CANDÈZE, Elat. nouv., fasc. 6 (1896) 46.

BALABAC (type locality).

117. MELANOXANTHUS RHOMBOIDALIS Candèze.

Melanoxanthus rhomboidalis CANDÈZE, Bull. Soc. ent. Belg. (1875) 123.

LUZON (type locality).

118. MELANOXANTHUS RIXOSUS Candèze.

Melanoxanthus rixosus CANDÈZE, Elat. nouv., fasc. 6 (1896) 45.

* LUZON, Laguna Province, Mount Maquiling (Hadden, January; Fleutiaux det.).

Originally described from Banguey Island.

MELANOXANTHUS SEXGUTTATUS Candèze.

Melanoxanthus sexguttatus CANDÈZE, Ann. Mus. Genova (1892) 799.

Without definite locality Schultze records this species from Luzon; it is otherwise known only from Engano. Its presence in the Philippines may be regarded as doubtful.

119. MELANOXANTHUS SEXTUS Candèze.

Melanoxanthus sextus CANDÈZE, Bull. Soc. ent. Belg. (1875) 124.

LUZON, Laguna Province, Mount Maquiling, 400 feet, on flowers of "sakat" (Hadden, March to July; Fleutiaux det.) : Tayabas Province, Malinao (Fleutiaux 5). MINDANAO (type locality).

119a. MELANOXANTHUS SEXTUS Candèze var.

LUZON, Laguna Province, Mount Maquiling, 3,000 feet, under bark (Hadden, April; Fleutiaux det.), on flowers of *Ixora finlaysoniana* and of *Vitex parviflora* (Hadden, July).

The variety is smaller than the typical form and lacks the median black marking on the pronotum.

120. MELANOXANTHUS SINGULARIS Candèze.

Melanoxanthus singularis CANDÈZE, Elat. nouv., fasc. 6 (1896) 46.

BALABAC (type locality).

Known also from Borneo, Sumatra, and Indo-China.

121. MELANOXANTHUS SUBCYLINDRICUS Candèze.

Melanoxanthus subcylindricus CANDÈZE, Elat. nouv., fasc 1 (1865) 35.

* LUZON, Laguna Province, Mount Maquiling (Hadden, May; Fleutiaux det.).

Originally described from Batchian in the Moluccas.

122. MELANOXANTHUS TERMINATUS Candèze.

Melanoxanthus terminatus CANDÈZE, Bull. Soc. ent. Belg. (1875) 124.

LUZON (type locality), Tayabas Province, Mount Banahao (Cornell collection).

123. MELANOXANTHUS VICINUS Fleutiaux.

Melanoxanthus militaris FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 225.

LUZON, Laguna Province, Mount Maquiling (type locality).

Hadden collected a series of this species on flowers of "malaklak" (*Clethra lancifolia*) on Mount Maquiling at 3,000 feet in April.

123a. MELANOXANTHUS VICINUS Fleutiaux var.

LUZON, Mountain Province, Baguio, 5,000 feet (Hadden, March; Fleutiaux det.); Mount Santo Tomas, 6,500 feet (Hadden, March).

MELANOXANTHUS ZEBRA (Wiedemann).

Elater zebra WIEDEMANN, Zool. Mag. 2 (1823) 107.

See *Melanoxanthus hemionus* Candèze.

Genus ANCHASTUS J. Leconte

124. ANCHASTUS FISCHERI nom. nov.

Melanoxanthus militaris FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 223; not *Anchastus militaris* Candèze, 1881.

LUZON, Tayabas Province, Mount Banahao (type locality).

In correspondence (March, 1935) Fleutiaux states that this species is an *Anchastus*. The original specific name is preoccupied by *Anchastus militaris* Candèze, 1881, from the western United States. The new name proposed is in honor of Mr. Arthur F. Fischer, director of the Philippine Bureau of Forestry.

125. ANCHASTUS FULVUS Fleutiaux.

Anchastus fulvus FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 227.

MINDANAO, Lanao Province, Iligan (type locality).

126. ANCHASTUS HADDENI Fleutiaux.

Anchastus haddeni FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 482.

LUZON, Mountain Province, Mount Santo Tomas, 6,000 feet (Hadden, March) (type locality).

Described from a single specimen.

127. ANCHASTUS NITIDUS Candèze.

Anchastus nitidus CANDÈZE, Elat. nouv., fasc 2 (1878) 25.
Anchastus sericeus CANDÈZE.

* BASILAN (Baker). * MINDANAO, Agusan Province, Butuan (Baker): Misamis Province, Dapitan (Baker): Surigao Province, Surigao (Baker) (all in the Fleutiaux collection).

Originally described from Borneo. The possible synonymy is suggested by Fleutiaux.

128. ANCHASTUS PHILIPPINENSIS Fleutiaux.

Anchastus philippinensis FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1932) 47.

LUZON, Laguna Province, Mount Maquiling (Hadden, April) (type locality).

129. ANCHASTUS RUFANGULUS Candèze.

Anchastus rufangulus CANÈZE, Bull. Soc. ent. Belg. (1875) 121.

LUZON, Laguna Province, Los Baños (Pemberton, March to June); Mount Maquiling (Fleutiaux 5). MINDANAO (type locality), Agusan Province, Butuan (Fleutiaux 5): Lanao Province, Iligan (Fleutiaux 5).

130. ANCHASTUS SERICEUS Candèze.

Anchastus sericeus CANDÈZE, Elat. nouv., fasc. 1 (1865) 27.

* LUZON, Laguna Province, Mount Maquiling (Hadden, May; Fleutiaux det.). MINDANAO, Agusan Province, Butuan (Fleutiaux 5): Misamis Province, Dapitan (Fleutiaux 5).

Originally described from Sarawak.

131. ANCHASTUS SUTURALIS Fleutiaux.

Anchastus suturalis FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 227.

MINDANAO, Agusan Province, Butuan (type locality).

132. ANCHASTUS UNICOLOR Candèze.

Anchastus unicolor CANDÈZE, Elat. nouv., fasc. 3 (1881) 61.

LUZON, Laguna Province, Los Baños (Fleutiaux 5); Mount Maquiling, 400 feet (Hadden, March and April): Tayabas Province, Mount Banahao (Fleutiaux 5). MINDANAO (type locality).

133. ANCHASTUS VITTATUS Fleutiaux.

Anchastus vittatus FLEUTIAUX, Philip. Journ. Sci. § D 9 (1914) 445.

LUZON, Laguna Province, Mount Maquiling (type locality).

Hadden took this species on Mount Maquiling in April.

133a. ANCHASTUS VITTATUS var. BAKERI Fleutiaux.

Anchastus vittatus var. *bakeri* FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 227.

LUZON, Laguna Province, Mount Maquiling (type locality).

134. ANCHASTUS VULNERATUS Candèze.

Anchastus vulneratus CANDÈZE, Elat. nouv., fasc. 2 (1878) 24; Elat. de l'Indochine Francaise, pt. 2 (1928) 144.

* BASILAN. * MINDANAO, Lanao Province, Kolambugan: Surigao Province, Surigao. * NEGROS, Oriental Negros Province, Cuernos Mountains (Baker). (All of the foregoing records are from the Fleutiaux collection.)

The species was described from Siam and is known also from Sumatra.

135. ANCHASTUS WILLIAMSI Fleutiaux.

Anchastus williamsi FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 482.

NEGROS (Williams, September) (type locality).

Described from a single specimen.

Genus HYPNOIDUS Stephens

136. **HYPNOIDUS (HYPDONUS) BAKERI Fleutiaux.**

Hypnoidus (Hypdonus) bakeri FLEUTIAUX, Philip. Journ. Sci. § D 9 (1914) 446.

LUZON, Laguna Province, Mount Maquiling (type locality). Known also from Borneo.

Genus ARRHAPHES Candèze

137. **ARRHAPHES HUMERALIS Fleutiaux.**

Arrhaphes humeralis FLEUTIAUX, Bull. Mus. Paris (1930) 638.

LUZON (Baker) (type locality).

Additional type specimens were from Tonkin.

Genus HEMIRRHAPHES Candèze

138. **HEMIRRHAPHES CANDÈZEI Fleutiaux.**

Hemirrhaphes candèzei FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 228.

LUZON, Laguna Province, Los Baños (Pemberton, March to June); Mount Maquiling (type locality), 2,000 feet (Hadden, June).

Known also from Banguey and Perak.

139. **HEMIRRHAPHES CRUCIATUS Fleutiaux.**

Hemirrhaphes cruciatus FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 228.

LUZON, Laguna Province, Mount Maquiling (type locality).

Genus QUASIMUS Gozis

140. **QUASIMUS HADDENI Fleutiaux.**

Quasimus haddeni FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 483.

BASILAN. LUZON, Mountain Province, Baguio (Williams, June) (Baker), 5,000 feet (Hadden, March); Mount Santo Tomas, 7,000 feet, sweeping (Hadden, March). MINDANAO, Misamis Province, Dapitan. (All of the foregoing are type localities.)

Genus CARDIOPHORUS Eschscholtz

141. **CARDIOPHORUS ALVINI Fleutiaux.**

Cardiophorus alvini FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 230.

LUZON, Laguna Province, Mount Maquiling: Tayabas Province, Malinao (type localities).

142. CARDIOPHORUS BAKERI Fleutiaux.

Cardiophorus elegans CANDÈZE, Ann. Mus. Genova (1878) 132.
Cardiophorus bakeri FLEUTIAUX, Philip. Journ. Sci. § D 9 (1914) 446 (new name for *C. elegans* Candèze 1878, nec Solier 1851).

LUZON, Laguna Provinces, Los Baños (Fleutiaux 5).

Originally described from Celebes; it is known also from Amboina.

143. CARDIOPHORUS BANKSI Fleutiaux.

Cardiophorus banksi FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 229.

LUZON, Laguna Province, Mount Maquiling. MINDANAO, Lanao Province, Iligan. PALAWAN, Puerto Princesa. (Type localities, all.)

144. CARDIOPHORUS FASCIATUS Candèze.

Cardiophorus fasciatus CANDÈZE, Bull. Soc. ent. Belg. (1875) 124.

LUZON (type locality).

145. CARDIOPHORUS INCONDITUS Candèze.

Cardiophorus inconditus CANDÈZE, Bull. Soc. ent. Belg. (1875) 125.

LUZON (type locality).

CARDIOPHORUS LIGNIPENNIS Candèze.

Cardiophorus lignipennis CANDÈZE, Elat. nouv., fasc. 4 (1889) 106.

Described from Ternate in the Moluccas and from Mindanao. In his 1891 catalogue Candèze omits reference to Mindanao, which may be a correction of the original citation.

146. CARDIOPHORUS LUZONICUS Eschscholtz.

Cardiophorus luzonicus ESCHSCHOLTZ, Thon. Arch. 2 (1829) 34.

"Manila" (type locality). LUZON (Schultze 5).

147. CARDIOPHORUS PALAWANUS Fleutiaux.

Cardiophorus palawanus FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 229.

NEGROS, Cuernos Mountains. PALAWAN, Puerto Princesa. (Type localities.)

148. CARDIOPHORUS PHILIPPINUS Fleutiaux.

Cardiophorus philippinus FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 229.

149. CARDIOPHORUS SPERNENDUS Candèze.

Cardiophorus spernendus CANDÈZE, Bull. Soc. ent. Belg. (1875) 125.

MINDANAO (type locality).

150. CARDIOPHORUS UNICOLOR Candèze.

Cardiophorus unicolor CANDÈZE, Bull. Soc. ent. Belg. (1875) 125.

BOHOL. LUZON. PANAY. "etc." (Type localities.)

150a. CARDIOPHORUS UNICOLOR var. STRIATUS Fleutiaux.

Cardiophorus unicolor var. *striatus* FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 228.

BOHOL. LUZON. MINDANAO. (Type localities.)

Genus ODONTOCARDUS Fleutiaux

151. ODONTOCARDUS RUFUS Fleutiaux.

Odontocardus rufus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 483.

BASILAN. MINDANAO, Lanao Province, Iligan: Misamis Province, Dapitan: Surigao Province: Bukidnon Province, Diklom, 2,000 feet (Phillips, March). NEGROS, Cuernos Mountains. (Type localities, all.)

152. ODONTOCARDUS ZWALUWENBURGI Fleutiaux.

Odontocardus zwaluwenburgi FLEUTIAUX, Bull. et Ann. Soc. ent. Belg. 74 (1934) 369.

MINDANAO, Surigao Province (type locality).

Genus CARDIOTARSUS Eschscholtz

153. CARDIOTARSUS FALLACIOSUS (Candèze).

Cardiophorus fallaciosus CANDÈZE, Elat. nouv., fasc. 6 (1896) 59.

PALAWAN, southern (type locality).

Genus NEODIPLOCONUS Hyslop

154. NEODIPLOCONUS ANGUSTUS Fleutiaux.

Neodiploconus angustus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 485.

LUZON, Mountain Province, Mount Data, 5,000 feet (Hadden, March) (type locality).

Described from a single specimen.

155. NEODIPLOCONUS BAKEWELLI (Fleutiaux).

Neodiploconus bakewelli FLEUTIAUX, Philip. Journ. Sci. § D 9 (1914) 447.

LUZON, Laguna Province, Los Baños; Mount Maquiling (type localities).

Numerous at 2,000 feet on Mount Maquiling in May and June (Hadden).

156. NEODIPLOCONUS CANTHARUS (Candèze).

Diploconus cantharus CANDÈZE, Elat. nouv., fasc. 5 (1892) 42.

BABUYANES (type locality). LUZON, Tayabas Province, Mount Banahao (Fleutiaux 5). MINDANAO (type locality), Misamis Province, Dapitan (Fleutiaux 5).

157. NEODIPLOCONUS CERVINUS (Candèze).

Diploconus cervinus CANDÈZE, Bull. Soc. ent. Belg. (1875) 125.

BABUYANES (type locality). LEYTE (type locality). LUZON, Benguet Subprovince, Irisan (Schultze 15). MINDANAO (type locality). * PANAY, Antique Province, Culasi (Cornell collection).

158. NEODIPLOCONUS CIPRINUS (Candèze).

Diploconus ciprinus CANDÈZE, Elat. nouv., fasc. 1 (1865) 47.

LUZON (type locality), Laguna Province, Mount Maquiling, 800 to 3,000 feet (Hadden, March to May; Fleutiaux det.). PANAY, Antique Province, Culasi (McGregor; Fleutiaux det., with a question).

Fairly abundant on Mount Maquiling.

159. NEODIPLOCONUS CONSANGUINEUS (Candèze).

Diploconus consanguineus CANDÈZE, Mon. des Elat. 1 (1860) 293.

All the islands (Candèze 2).

Described from Malaysia.

160. NEODIPLOCONUS COXALIS Fleutiaux.

Neodiploconus coxalis FLEUTIAUX, Philip. Journ. Sci. 49 (1932) 568.

LUZON, Laguna Province, Mount Maquiling, 400 feet (Hadden, June); Pangil (Hadden, May): Tayabas Province, Quezon Park (Hadden, May) (type localities).

161. NEODIPLOCONUS ERYTHRONOTUS (Candèze).

Diploconus erythronotus CANDÈZE, Elat. nouv., fasc. 1 (1865) 46.

LUZON (type locality), Laguna Province, Agricultural College (Hadden, May); Los Baños (Schultze 15); Mount Maquiling (Fleutiaux 4); Pangil (Hadden, May): Mountain Province, Baguio ("Bacio") (Cornell collection): Nueva Vizcaya Province, Imugan (Cornell collection): Tayabas Province, Mount Banahao (Cornell collection).

161a. NEODIPLOCONUS ERYTHRONOTUS (Candèze) var.

LUZON, Pangasinan Province, Asingan (Hadden, May; Fleutiaux det.).

In the single specimen seen, the elytra are red instead of blackish, being only slightly darker than the pronotum.

162. NEODIPLOCONUS FLEUTIAUXI Van Zwaluwenburg.

Diploconus nitidus FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 231; nec *Diploconus nitidus* SCHWARZ, 1902.

Neodiploconus fleutiauxi VAN ZWALUWENBURG, Ann. & Mag. Nat. Hist. X 13 (1934) 596 (new name).

LUZON, Camarines Sur Province, Iriga (Hadden, June) : Tayabas Province, Mount Banahao (type locality).

163. NEODIPLOCONUS FUSCUS Fleutiaux.

Neodiploconus fuscus FLEUTIAUX, Philip. Journ. Sci. 49 (1932) 569.

LUZON, Laguna Province, Mount Maquiling, 400 feet (Hadden, June) (type locality) : Mountain Province, Mount Polis, Ifugao, 3,000 feet (Hadden, July; Fleutiaux det.).

164. NEODIPLOCONUS HADDENI Fleutiaux.

Neodiploconus haddeni FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1932) 48.

LUZON, Laguna Province, Mount Maquiling, 400 feet (Hadden, April) : Mountain Province, Baguio (Williams, June) (Baker) (type localities).

165. NEODIPLOCONUS MARGINATUS Fleutiaux.

Neodiploconus marginatus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1932) 49.

LUZON, Mountain Province, Baguio (Williams, June) (Baker) (type locality) ; Mount Polis, Ifugao, 3,000 feet (Hadden, July) : Nueva Vizcaya Province, Imugan (Cornell collection).

166. NEODIPLOCONUS NIGRIPES Fleutiaux.

Neodiploconus nigripes FLEUTIAUX, Philip. Journ. Sci. 49 (1932) 568.

LUZON, Laguna Province, Mount Maquiling (type locality) (Hadden, May) : Mountain Province, Baguio, 5,000 feet (type locality) ; Camp 82, 6,000 feet (Hadden, March) ; Mount Data, 5,000 feet (Hadden, March) (type locality).

167. NEODIPLOCONUS NITENS Fleutiaux.

Neodiploconus nitens FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 484.

LUZON, Mountain Province, Camp 82, 6,000 feet (Hadden, May) (type locality).

168. NEODIPLOCONUS PHILIPPINENSIS (Fleutiaux).

Diploconus philippinensis FLEUTIAUX, Philip. Journ. Sci. § D 9 (1914) 447.

LUZON, Laguna Province, Mount Maquiling (type locality). * MINDANAO, Bukidnon Province, Santa Fe, 2,000 feet (Phillips, June) : Lanao Province, Kolambugan (Fleutiaux collection) : Zamboanga Province, Kabasalan (Muzzall, March and April; Fleutiaux det.).

169. NEODIPLOCONUS POLITUS (Candèze).

Diploconus politus CANDÈZE, Bull. Soc. ent. Belg. (1875) 126.

ALABAT (type locality). LUZON, Laguna Province, Los Baños and Mount Maquiling (Fleutiaux 4).

Hadden took it on Mount Maquiling at from 400 to 3,000 feet from April to June on flowers of *Clethra lancifolia.*

170. NEODIPLOCONUS SURDUS Fleutiaux.

Neodiploconus surdus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 484.

MINDANAO, Bukidnon Province, Diklom, 2,000 feet (Phillips, March); Tangcolan (Baker) (type localities).

171. NEODIPLOCONUS UMBILICATUS (Candèze).

Diploconus umbilicatus CANDÈZE, Bull. Soc. ent. Belg. (1875) 125.
Diploconus angusticollis CANDÈZE.
Diploconus obscurus FLEUTIAUX.

All the islands (Candèze 2, p. cxxvi). LUZON, Laguna Province, Los Baños (Schultze 15); Mount Linian (Fleutiaux 5); Mount Maquiling, 400 feet (Hadden, April and May); Pangil (Hadden, May): Mountain Province, Baguio (Williams, June): Tayabas Province, Mount Banahao (Fleutiaux 5); Quezon Park, 1,000 feet (Hadden, June). PANAON (type locality). * PANAY, Antique Province, Culasi (Cornell collection).

Genus METRIAULACUS Schwarz

172. METRIAULACUS GOBIUS (Candèze).

Melanotus gobius CANDÈZE, Mon. des Elat. 3 (1860) 329.

Recorded by Fleutiaux (9, part 5, p. 214) from the Philippines, without specific locality. Originally described from Java; it occurs also in Indo-China and northern India.

Genus MELANOTUS Eschscholtz

173. MELANOTUS (SPHENISCOSOMUS) ALBIVELLUS Candèze.

Melanotus (*Spheniscosomus*) *albivellus* CANDÈZE, Elat. nouv., fasc. 1 (1865) 48.

* LUZON, Laguna Province, Mount Maquiling (Hadden, April; Fleutiaux det.).

Known also from Borneo, Java, Sumatra, Indo-China, and Penang.

174. MELANOTUS EBENINUS Candèze.

Melanotus ebeninus CANDÈZE, Mon. des Elat. 3 (1860) 335.

BATAN, Batanes (Schultze 15). JOLO (Fleutiaux 4). LUZON, Rizal Province, Pasay (McGregor, July, at light): Camarines Sur Province, Iriga (Hadden, June): Isabela Province, San Luis

(Schultze 15) : Laguna Province, Agricultural College (Pemberton, March to June) ; Los Baños (Fleutiaux 4) ; Mount Maquiling, bred from dead wood of "taluto" (*Pterocymbium tinctorium*) and on flowers of *Sapindus saponaria* (Hadden, November) ; Pangil (Hadden, May) : Nueva Vizcaya Province, Imugan (Cornell collection) : Tarlac Province (Schultze 15) : Tayabas Province, Quezon Park (Hadden, June). MINDANAO, Bukidnon Province, Diklom, 3,000 feet (Phillips, March) : Lanao Province, Iligan (Fleutiaux 5) : Misamis Province, Cagayan (Fleutiaux 5) : Zamboanga Province, Kabasalan (Muzzall, April and May). * PANAY, Antique Province, Culasi (Cornell collection).

175. MELANOTUS INTERJECTUS Candèze.

Melanotus interjectus CANDÈZE, Elat. nouv., fasc. 6 (1896) 65.

BALABAC (type locality).

176. MELANOTUS PHLOGOSUS Candèze.

Melanotus phlogosus CANDÈZE, Mon. des Elat. 3 (1860) 325.

LUZON (Schultze 15).

Originally described from the Philippines and southern China.

177. MELANOTUS PISCICULUS Candèze.

Melanotus pisciculus CANDÈZE, Mon. des Elat. 3 (1860) 330.

LUZON, Manila (type locality).

178. MELANOTUS SCRIBANUS Candèze.

Melanotus scribanus CANDÈZE, Elat. nuov., fasc. 5 (1893) 48.

LUZON, Laguna Province, Mount Maquiling (Schultze 15). MINDORO (type locality).

178a. MELANOTUS SCRIBANUS var. BAKERI Fleutiaux.

Melanotus scribanus var. *bakeri* FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 231.

LUZON, Laguna Province, Los Baños, Mount Maquiling (type localities) : Manila (Cornell collection). * MINDANAO, Zamboanga Province, Kabasalan (Muzzall, March and April; Fleutiaux det.).

Hadden collected it on flowers of "santan puti" at 3,000 feet on Mount Maquiling in July.

Genus PRISTILOPHUS Germar

179. PRISTILOPHUS LUZONICUS (Candèze).

Corymbites luzonicus CANDÈZE, Elat. nouv., fasc. 1 (1865) 53.

All the islands (Candèze 2). LUZON (type locality), Laguna Province, Mount Maquiling (Fleutiaux 4) : Tayabas Province, Mount Banahao (Cornell collection).

Fairly common at 400 feet on Mount Maquiling, April to June (Hadden).

Genus LUZONICUS Fleutiaux

180. LUZONICUS BAKERI Fleutiaux.

Luzonicus bakeri FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 232.

LUZON, Laguna Province, Mount Maquiling (type locality).

Genus NEOTRICHOPHORUS Jacobson

181. NEOTRICHOPHORUS GERMANUS (Candèze) var.

Ludius germanus CANDÈZE, Ann. Mus. Genova (1894) 498.

Fleutiaux (5) records variety *a* from Mindanao, Agusan Province, Iligan. The typical form and the variety are known from Sumatra.

182. NEOTRICHOPHORUS HIRSUTUS (Candèze).

Ludius hirsutus CANDÈZE, Bull. Soc. ent. Belg. (1875) 126.

LUZON, Laguna Province, Mount Maquiling (Fleutiaux 4): Tayabas Province, Mount Banahao (Cornell collection). PALAWAN, Puerto Princesa (Fleutiaux 5).

183. NEOTRICHOPHORUS PHILLIPSI sp. nov.

Female, 10 millimeters. Head and thorax prominent, rest of body strongly narrowed; elytra little more than twice length of head and prothorax. Jet black above and beneath, antennæ entirely black; rather shiny, especially pronotum; trochanters and femora luteous, tibiæ piceous to black, tarsi dark rufous. Clothed with semierect, rather dense hairs, varying with the location: On head very fine, fulvous; on pronotum cinereous, becoming coarser toward sides and base; on elytra very fine, fulvous to obscure on disc, and (best seen from the rear) a band of fulvous, coarser hairs along suture, widening distally, with another similar band along the side margin; beneath, hairs short, fairly fine, fulvous.

Head very precipitous, flattened in front, margin acutely rounded; rather finely and evenly punctate. Antennæ with fulvous to black hairs; exceeding the posterior angles of pronotum by about two and one-half joints; 2d and 3d subcylindrical, subequal, together about two-thirds length of 4th; 4th to 10th serrate; 11th elongate, attenuate on distal half.

Pronotum about half as long again as wide, strongly convex; punctation as on head, uniform; sides subparallel, narrowed on anterior fifth; posterior angles faintly divergent, incurved at tips, strongly unicarinate, the carina diverging sharply from

the lateral margin; a group of two or three black bristles projecting laterally from the tips at about a 90° angle. Basal declivity abrupt; a median impressed line on basal half. Mucro horizontal, slightly up-curved behind coxæ. Mesosternal cavity more or less horizontal; metasternum strongly convex anteriorly.

Scutellum precipitous, elongate-triangular, finely punctate.

Elytra, at humeri only, about as wide as prothorax; attenuate to about posterior third, and thence more sharply to the conjointly rounded apex; sutural margins faintly divergent apically. Striæ consisting of rather coarse punctations which become much finer posteriorly; intervals nearly flat, finely punctate (subrugosely toward base). Body beneath finely and uniformly punctate.

Described from a holotype female. Differs from similar described species by the distinctive hair pattern on the elytra, which is difficult to see from the anterior end. Otherwise it seems closest to *antennatus* Candèze and *illotipes* Candèze; in the former species the last three antennal joints are said to be flavous, whereas in *phillipsi* all the joints are black; Candèze describes the elytral tips of *illotipes* as emarginate, while in the present species they are definitely entire.

The type is in the collection of the Experiment Station, Hawaiian Sugar Planters' Association, Honolulu, T. H. The species is dedicated to Mr. L. H. Phillips, of Bugo, Misamis, Mindanao, whose collecting has added considerably to our knowledge of the elaterid fauna of Mindanao.

MINDANAO, Bukidnon Province, Diklom, 3,000 feet (Phillips, April).

Genus APHANOBIUS Eschscholtz

184. APHANOBIUS LONGICOLLIS Eschscholtz.

Aphanobius longicollis ESCHSCHOLTZ, Thon. Arch. 2 (1829) 33.
Aphanobius longus CANDÈZE.

"Manilla" (type locality). MINDANAO, Bukidnon Province, Diklom, 2,000 feet (Phillips, March; Fleutiaux det.).

Known also from Borneo and Java.

APHANOBIUS LONGITHORAX (Wiedemann).

Elater longithorax WIEDEMANN, Zool. Mag. 2 (1823) 106.

Philippine references to this species (including Schultze's record of Balabac) are doubtful. Schenkling's Catalogue incorrectly synonymizes *A. longus* Candèze under this, instead of the preceding, species. *Aphanobius longithorax* is known from Bengal.

Genus PARALLELOSTETHUS Schwarz

185. PARALLELOSTETHUS CONCIPENNIS (Schwarz).

Steatoderus concipennis SCHWARZ, Stett. Ent. Zeit. (1902) 296.

Philippines (type locality).

Genus LUDIGENUS Candèze

186. LUDIGENUS POLITUS Candèze.

Ludigenus politus CANDÈZE, Mon. des Elat. 4 (1863) 326.

Widespread, especially in the south (Candèze 2). LUZON, Camarines Sur Province, Iriga (Hadden, June); Mabatobato, Pili (Hadden, May): Laguna Province, Agricultural College (Hadden); Mount Maquiling, 400 to 800 feet (Hadden, May, June, August, October); Pangil (Hadden). MINDANAO (Candèze 2); Zamboanga Province, Tambanan (Muzzall; Fleutiaux det.). NEGROS, Mount Canlaon (Schultze 15). PALAWAN, Bacuit (Schultze 15). SIBUYAN (Schultze 15).

Originally described from the Philippines, Borneo, and Siam; this species is known also from Celebes, Indo-China, and the Andamans.

Genus AGONISCHIUS Candèze

187. AGONISCHIUS BAKERI Fleutiaux.

Agonischius bakeri FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 232.

LUZON, Tayabas Province, Mount Banahao (type locality).

188. AGONISCHIUS BALABAKENSIS Candèze.

Agonischius balabakensis CANDÈZE, Elat. nouv., fasc. 6 (1895) 77.

BALABAC (type locality).

189. AGONISCHIUS BASALIS Candèze.

Agonischius basalis CANDÈZE, Bull. Soc. ent. Belg. (1875) 127.

LUZON (type locality), Ambos Camarines Province, Mount Isarog (Cornell collection): Laguna Province, Mount Maquiling, up to 800 feet, on flowers of *Terminalia nitens*, of *Ehretia philippinensis*, and of *Clethra lancifolia* (Hadden, April to June): Nueva Vizcaya Province, Imugan (Cornell collection): Tayabas Province, Mount Banahao (Cornell collection).

189a. AGONISCHIUS BASALIS Candèze var.

* MINDANAO, Bukidnon Province, Diklom, 3,000 feet (Phillips, March; Fleutiaux det.): Lanao Province, Kolambugan (Cornell collection): Zamboanga Province, Kabasalan, on flowers (Muzzall, August).

Differs from the typical form in having a rufous stripe on the outer margin of the elytra for about two-thirds their length.

190. AGONISCHIUS BREVICOLLIS Candèze.

Agonischius brevicollis CANDÈZE, Bull. Soc. ent. Belg. (1875) 127.

LUZON (type locality).

191. AGONISCHIUS FUSIFORMIS Candèze.

Agonischius fusiformis CANDÈZE, Bull. Soc. ent. Belg. (1875) 127.

* LUZON, Ambos Camarines Province, Mount Isarog (Cornell collection): Laguna Province, Mount Maquiling, under bark (Hadden, February to June; Fleutiaux det.): Nueva Vizcaya Province, Imugan (Cornell collection): Tayabas Province, Quezon Park (Hadden, May). MINDANAO (type locality), Lanao Province, Momungan (Cornell collection): Zamboanga Province, Kabasalan, on flowers (Muzzall, March and August).

192. AGONISCHIUS MARGINATUS Candèze.

Agonischius marginatus CANDÈZE, Bull. Soc. ent. Belg. (1875) 127.

MINDANAO (type locality).

193. AGONISCHIUS MUZZALLI Fleutiaux.

Agonischius muzzalli FLEUTIAUX, Proc. Haw. Ent. Soc. **8** (1934) 485.

MINDANAO, Misamis Province, Dapitan (Baker): Zamboanga Province, Kabasalan (Muzzall, March) (type localities).

194. AGONISCHIUS NIGERRIMUS Fleutiaux.

Agonischius nigerrimus FLEUTIAUX, Bull. et. Ann. Soc. ent. Belg. **74** (1934) 369.

LUZON, Nueva Vizcaya Province, Imugan (Cornell collection) (type locality).

195. AGONISCHIUS PRAEUSTUS Fleutiaux.

Agonischius praeustus FLEUTIAUX, Proc. Haw. Ent. Soc. **8** (1934) 485.

LUZON, Laguna Province, Mount Maquiling (Hadden, June) (type locality).

Described from a single specimen.

Genus GLYPHONYX Candèze

196. GLYPHONYX ATTONITUS Candèze.

Glyphonyx attonitus CANDÈZE, Elat. nouv., fasc. 6 (1896) 78.

LUZON, Laguna Province, Los Baños (Schultze 15). PALAWAN (type locality).

Although this was considered by Candèze to be a variety of his *G. erraticus*, Fleutiaux (4) believes it to be a valid species.

197. GLYPHONYX DISSIMILIS Candèze.

Glyphonyx dissimilis CANDÈZE, Elat. nouv., fasc. 6 (1896) 78.

BALABAC (Schultze 15).

Type locality Borneo.

198. GLYPHONYX ERRATICUS Candèze.

Glyphonyx erraticus CANDÈZE, Bull. Soc. ent. Belg. (1875) 127.

LUZON (type locality); Laguna Province, Mount Maquiling, 2,000 feet (Hadden, June; Fleutiaux det.): Tayabas Province, Mount Banahao (Fleutiaux 5). MINDANAO (type locality); Agusan Province, Butuan (Fleutiaux 5): Zamboanga Province, Kabasalan (Muzzall, March and April).

199. GLYPHONYX FALSUS Candèze.

Glyphonyx falsus CANDÈZE, Elat. nouv., fasc. 6 (1896) 78.

BALABAC (Schultze 15). MINDANAO, Agusan Province, Butuan (Fleutiaux 5). PALAWAN, southern (type locality).

Known also from Java.

200. GLYPHONYX FENEUS Candèze.

Glyphonyx feneus CANDÈZE, Elat. nouv., fasc. 6 (1896) 78.

BALABAC (type locality). LUZON, Laguna Province, Los Baños (Fleutiaux 5); Mount Maquiling 2,000 feet (Hadden, June): Tayabas Province, Mount Banahao (Fleutiaux 5).

GLYPHONYX ORNATUS Fleutiaux.

Glyphonyx ornatus FLEUTIAUX, Philip. Journ. Sci. § D 11 (1916) 233.

See *Megapenthes lewisi* Fleutiaux.

201. GLYPHONYX POSTICUS Candèze.

Glyphonyx posticus CANDÈZE, Bull. Soc. ent. Belg. (1875) 127.

LUZON, Laguna Province, Mount Maquiling (Fleutiaux 5). MINDANAO (type locality), Agusan Province, Butuan (Fleutiaux 5): Zamboanga Province, Kabasalan, on flowers (Muzzall, April, May, August).

Genus SILESIS Candèze

202. SILESIS CASTANEUS Fleutiaux.

Silesis castaneus FLEUTIAUX, Proc. Haw. Ent. Soc. 8 (1934) 486.

* LUZON, Laguna Province, Mount Maquiling, 2,000 feet, on *Vitex parviflora* (Hadden, June; Fleutiaux det.). MINDANAO (type locality), Bukidnon Province, Diklom, 3,000 feet (Phillips, March): Zamboanga Province, Kabasalan (Muzzall, March).

Genus HEMIOPS Laporte de Castelnau

203. HEMIOPS FLAVA Castelnau.

Hemiops flava CASTELNAU, Silbermann's Rev. Ent. 4 (1836) 15.

Recorded by Fleutiaux (7, p. 175) from the Philippines without more exact data. The species is known also from China, Malaysia, and Java.

204. HEMIOPS SEMPERI Candèze.

Hemiops semperi CANDÈZE, Elat. nouv., fasc. 2 (1878) 53.

LUZON (type locality), Laguna Province, Los Baños (Williams, June, October, November); Mount Maquiling, 400 feet (Hadden, April to October): Rizal Province, Montalban Gorge (Schultze 15): Tayabas Province, Mount Banahao (Cornell collection). NEGROS, Occidental Negros Province, Mount Canlaon (Schultze 15). * PANAY, Antique Province, Culasi (Cornell collection).

Genus THAROPSIDES Fleutiaux

THAROPSIDES BAKERI Fleutiaux.

Tharopsides bakeri FLEUTIAUX, Bull. Mus. Paris (1918) 236, footnote.

See *Eumoeus bakeri* (Fleutiaux).

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   Part 2: Encycl. Ent., Coleop. III (1928) 103–177.
   Part 3: Bull. Mus. Paris II 2 (1930) 636–644.
   Part 4: Bull. Soc. zool. France 56 (1931) 306–334.
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STUDIES ON PHILIPPINE MORDELLIDÆ (COLEOPTERA), II[1]

By EUGENE RAY

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The following descriptions are the result of a further study of the Philippine Mordellidæ contained in the collection of Dr. F. J. Psota, of Chicago, Illinois. Two of the species were collected by C. F. Clagg on Mindanao in 1930, the others by the late C. F. Baker in 1915. All specimens, including types, remain in the collection of Dr. F. J. Psota.

A list of the known Philippine Mordellidæ is appended in order to facilitate recognition of members of this obscure family of Coleoptera.

DELLAMORA PUBESCENS sp. nov.

Moderately elongate, densely covered with fine, flavous, recumbent pubescence. Derm of head and prothorax castaneous, that of elytra fuscous. Maxillary palpi castaneous, apical segment large, triangular; mandibles fuscous; antennæ flavous, long, reaching second abdominal segment, segments 2 and 3 short, equal, together as long as 4, 4 to 11 subequal, 11 rounded, slightly enlarged at apical third. Ventral surface fuscous, covered with recumbent, flavous pubescence, less dense than on dorsal surface; anterior legs, intermediate femora, and terminal segment of posterior tarsi castaneous, remainder fuscous; penultimate segment of anterior and intermediate tarsi bilobed; posterior tibiæ with three oblique, parallel, equal ridges, each extending one-third across external surface; basitarsi with four short ridges, second and third segments each with two ridges. Anal style long, stout, truncate at apex, as long as the two apical ventral segments together. Length to end of elytra, 5.5 mm; to apex of anal style, 6.7.

One specimen, holotype, male, La Lun Mountains, Mindanao, July 3, 1930 (*C. F. Clagg*).

[1] Studies on Philippine Mordellidæ, I, Coleopterological Contributions 1 (1930) 143–158, pls. 25 and 26.

This species may be separated from the other Philippine members of the genus by the difference in the number of the ridges on the posterior tibiæ and tarsi, and the peculiar color and antennal segmentation.

MORDELLISTENA CLAGGI sp. nov.

Moderately elongate, slender; surface covered with dense, long pubescence, partaking of ground color; head castaneous, pronotum lighter, with a pair of subapical marginal spots and a central postmedian one; elytra piceous. Head convex; antennæ castaneous, long, reaching basal abdominal segment. Segments 1 and 2 and 3 and 4 equal to each other, 5 to 10 broadened, 11 twice as long as 10; maxillary palpi large, flavous, apical segment enlarged, broadly triangular, outer edge curved; eyes large, piceous, margin irregularly flavous. Pronotum convex, sides parallel, basal angles slightly obtuse, midbasal lobe pronounced, covering part of scutellum. Elytra elongate, sides parallel to within one-fifth of apex. Ventral surface piceous, last dorsal and ventral abdominal segments castaneous, former two and one-half times length of latter and attenuate to apex. Anterior femora, posterior tarsi, and a small area at base of hind femora flavous; anterior tibiæ and tarsi and intermediate legs fuscous, posterior femora and tibiæ piceous. Hind tibiæ with two ridges, anterior one extending entirely across outer face; first and second segments of posterior tarsi each with two ridges. Length to end of elytra, 1.9 mm; to apex of anal style, 2.2.

One specimen, holotype, male, Lawa, Davao Province, Mindanao, May 5, 1930 (*C. F. Clagg*). The species is dedicated to the collector.

This species is distinct from any of the Indo-Australasian members of the genus, its closest relative being *gracilicauda* Blair,[2] from which it differs in its dissimilar antennæ, more parallel form, attenuate anal style, darker color, and the longer anterior ridge of the posterior tibiæ.

DICLIDIA OCEANICA sp. nov.

Oblong-oval; upper surface transversely strigate and clothed with fine, grayish pubescence, placed longitudinally. Head piceous, front flavous, outer edge of mandibles black; maxillary palpi flavous, terminal segment enlarged, rounded-triangular; antennal segments 1 to 7 flavous, 8 darker (9 to 11 missing);

[2] *Mordellistena gracilicauda* Blair, Ann. & Mag. Nat. Hist. IX 9 (1922) 568. (Fiji.)

basal segment two-thirds as long as 2; 3 and 4 together equal to 2; 5 and 6 equal; 7 and 8 each equal in length to 3, but broader. Prothorax piceous; sides rounded. Elytra piceous, elongate, rounded at apex. Ventral surface piceous, grayish pubescent. Legs piceo-castaneous, tarsi paler; spurs of hind tibiæ subequal. Length, 2 mm.

One specimen, holotype, female, "Philippine Is.," May 20, 1916 (*C. F. Baker*).

This species and the one following are the first two members of the genus to be described from this part of the globe, the only previously known forms having been recorded from North America.

These species differ from the Nearctic forms chiefly in the different relative lengths of the various antennal segments.

DICLIDIA ANTIPODES sp. nov.

Oblong-oval, moderately elongate; upper surface transversely strigate; reddish brown, covered with fine grayish pubescence. Head and maxillary palpi reddish brown; antennæ piceous, segments 1 and 2 castaneous, 3 to 11 grayish to pubescent, 7 to 11 transverse, forming an elongate club; segments 1 to 3 equal, 4 and 5 shorter, equal to each other, 6 equal to 2. Ventral surface, including legs, castaneous; abdominal segments somewhat darker. Length, 2 to 2.3 mm.

Five specimens, holotype, male, allotype, female, and paratype, male, Tankulan, Mindanao, June 14, 1915; two paratypes, female, Bayombong, Luzon, May 10, 1916; all collected by C. F. Baker.

LIST OF PHILIPPINE MORDELLIDÆ

MORDELLINÆ

Genus GLIPA Leconte

Glipa LECONTE, Colleop. of Kans. & E. New Mex. (1857) 17.

1. *aurata* RAY, Coleop. Contrib., I, No. 3 (1930) 145, pl. 26, fig. 3.
2. *baeri* PIC, Mel. exot.-ent., fasc. 25 (1917) 22; RAY, Coleop. Contr., I, No. 3 (1930) 146, pl. 26, fig. 1.
3. *bakeri* RAY, Coleop. Contr., I, No. 3 (1930) 146, pl. 26, fig. 4.
4. *balabacana* PIC, Mel. exot.-ent., fasc. 26 (1917) 12.
5. *isolata* RAY, Coleop. Contr., I, No. 3 (1930) 145, pl. 26, fig. 5.
6. *malaccana* PIC, Echange 27 (1911) 190; RAY, Coleop. Contr., I, No. 3 (1930) 14, pl. 25, figs. 3, 4; pl. 26, fig. 6.
7. *palawana* PIC, Mel. exot.-ent., fasc. 40 (1923) 29.

Genus TOMOXIA Costa

Tomoxia COSTA, Fauna Regni Napoli, Mordell. (1854) 8.

1. *antipodes* RAY, Coleop. Contr., I, No. 3 (1930) 149.
2. *diversimaculata* RAY, Coleop. Contr., I, No. 3 (1930) 147.
3. *intermedia* RAY, Coleop. Contr., I, No. 3 (1930) 149.
4. *philippinensis* RAY, Coleop. Contr., I, No. 3 (1930) 148.

Genus MORDELLA Linnæus

Mordella LINNÆUS, Syst. Nat. ed. 10 (1758) 420.

1. *bistrinotata* PIC, Mel. exot.-ent., fasc. 52 (1928) 12; RAY, Coleop. Contr., I, No. 3 (1930) 150.
2. *composita* WALKER,[3] Ann. & Mag. Nat. Hist. III, 2 (1858) 286; RAY, Coleop. Contr., I, No. 3 (1930) 151.

Genus DELLAMORA Normand

Dellamora NORMAND, Bull. Soc. ent. France (1917) 284.

1. *antipodes* RAY, Coleop. Contr., I, No. 3 (1930) 153.
2. *bakeri* RAY, Coleop. Contr., I, No. 3 (1930) 152, pl. 25, fig. 5.
3. *iridescens* RAY, Coleop. Contr., I, No. 3 (1930) 154.
4. *maculata* RAY, Coleop. Contr., I, No. 3 (1930) 153.
5. *ochracea* RAY, Coleop. Contr., I, No. 3 (1930) 153.
6. *philippinensis* RAY, Coleop. Contr., I, No. 3 (1930) 151, pl. 25, fig. 6.
7. *pubescens* sp. nov.

Genus MORDELLISTENA Costa

Mordellistena COSTA, Fauna Regni Napoli, Mord. (1854) 16, 31.

1. *claggi* sp. nov.
2. *longicauda* RAY, Coleop. Contr., I, No. 3 (1930) 155.

ANASPINÆ

Genus DICLIDIA Leconte

Diclidia LECONTE, Proc. Acad. Nat. Sci. Phila. 14 (1862) 43.

1. *antipodes* sp. nov.
2. *oceanica* sp. nov.

[3] This determination has been questioned in private correspondence by K. G. Blair, of the British Museum.

PHILIPPINE RUSTS IN THE CLEMENS COLLECTION 1923–1926, I[1]

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THREE PLATES

It is not common for a collector of phanerogamic plants and fern allies to include also the much less conspicuous microfungi. There is consequently more than usual credit to be given to Mrs. Mary S. Clemens for her extensive and discriminating work in gathering the rich tropical vegetation and preserving it in suitable form for study by specialists, and especially for the attention that she has given to the parasitic fungi. Mrs. Clemens began sending the senior author a few collections of rusts from the Philippines in 1923. Her interest in this group of fungi increased, and has continued to the present time, until few regions of the tropical world have been so thoroughly explored. Marvelous endurance and an intrepid nature have overcome almost unbelievable obstacles in penetrating jungles and ascending the highest mountains. Aided by her husband, and imbued with the devoted spirit of Protestant missionaries, she has covered a large part of the Philippine area.

It was the original intention that the senior author should study the collections as they were received, but after one futile effort the material came in such abundance, and other duties pressed so heavily, that only desultory efforts were made until Doctor Cummins joined in the work. As joint author he has shown much zeal in assorting and determining the collections. They embrace what Mrs. Clemens had sent between the years 1923 and 1926. It now appears possible after ten years of delay to report on all material that has been received. The hosts have been verified or determined by Dr. E. D. Merrill.

The first installment presented herewith embraces rusts occurring on monocotyledonous hosts and one species on Pinaceæ.

[1] Contribution from the Department of Botany, Purdue University Agricultural Experiment Station, Lafayette, Indiana.

There are fifty-one species, represented by ninety-six collections. It is with more than usual pleasure that we are able to name a new species in honor of Mrs. Clemens, especially as it belongs to a rare and recently established genus not before reported outside of tropical America. All types are deposited in the Arthur Herbarium, Purdue University.

ON PINACEÆ

1. **PERIDERMIUM INSULARE** Syd.

On *Pinus insularis* Endl., LUZON, Benguet Subprovince, Mount Santo Tomas, February 19, 1935, *Clemens s. n.;* February 24 to 27, 1925, *Clemens 4967.*

ON GRAMINEÆ

2. **ANGIOPSORA CLEMENSAE** sp. nov. Plate 1, fig. 1.

Uredia hypophylla, minuta, ca. 50–100 μ diam., flavida, in centro poro aperta, corona densissima paraphysium introrsar curvatar cincta; urediosporae obovoideae vel ellipsoideae, 16–19 x 21–26 μ; membrana 1 μ cr., pallide brunnea, dense et breviter echinulata, poris germ. obscuris, 4, equatorialibus. Telia hypophylla, atra, aggregata in macula 1–5 mm lata, 3–10 mm longa; teliosporae oblongae, 10–15 x 16–29 μ; membrana 1.5 μ cr., ad apicem leviter incrassata, 2–3 μ, cinnamomea, epedicellata, levis.

On *Panicum Warburgii* Mez., LUZON, Pangasinan Province, Anda, March 24, 1925, *Clemens 6946.*

This species, a typical *Angiopsora* in both uredia and telia, adds a genus of hosts, and also extends the range of the genus beyond that reported by Mains [2] when he separated the genus from *Puccinia.* The species is named in honor of the collector, Mrs. Mary Strong Clemens, whose collections have greatly advanced our knowledge of the Uredinales of the Philippine Islands.

3. **PUCCINIA ORIENTALIS** (Syd. and Butl.) comb. nov.

Diorchidium orientale Syd. and Butl.

On *Panicum Warburgii* Mez., LUZON, Manila, October 2, 1923, *Clemens 1601;* February 14, 1924, *Clemens 1601a, 1601b:* Pangasinan Province, Anda, March 23, 1935, *Clemens s. n.* On *Panicum* sp., LUZON, Bulacan Province, Sibul Springs, December, 1924, *Clemens 4943.*

[2] Mycologia 26 (1934) 122–132.

The hosts of *1601*, *1601a*, and *1601b* were originally identified in part as *Isachne miliacea*. Most of the material was seen by both Doctor Merrill and Doctor Hitchcock, who finally decided that the host probably is *Panicum Warburgii* for all three numbers. The rust has not been reported on grasses other than *Panicum*.

4. **PUCCINIA SUBCENTRIPORA** sp. nov. Plate 2, fig. 3.

Uredia hypophylla, brunnea; urediosporae ellipsoideae vel globosae, 24–30 x 29–39 μ; membrana 3–4 μ cr., fuscobrunnea, echinulata, poris germ. 4, equatorialibus. Telia non visa; teliosporae oblongae vel ellipsoideae, 19–26 x 29–39 μ; membrana ubique 1.5–2 μ cr., castaneo-brunnea, levi, poris in media cellula inferna; pedicelo hyalino, brevi, fragili.

On *Panicum punctatum* Burm., LUZON, Pangasinan Province, Rosales, February 1 to 14, 1925, *Clemens 5897:* Nueva Ecija Province, Gapan, February 1 to 14, 1925, *Clemens 5898* (type).

Species of *Puccinia* which have teliospores with a uniform wall and the lower germ pore below the septum are uncommon on grasses. For that reason this species is interesting and distinct. The urediospores often appear to be verrucose, due to the thickness of the wall and the closeness of the sculpturing, but are echinulate.

This species appears to be closely related to *Puccinia brachycarpa* Syd. but differs in having larger urediospores and teliospores with smooth walls.

5. **PUCCINIA LEVIS** (Sacc. and Bizz.) Magn.

On *Digitaria corymbosa* (Roxb.) Merr., MINDANAO, Davao Province, Todaya, Mount Apo, June 17 and 18, 1924, *Clemens 2064, 2064a.*

6. **PUCCINIA PASPALICOLA** (P. Henn.) Arth.

On *Digitaria sanguinalis* (L.) Scop. var. *australis* Thwait., LUZON, Manila, December 7, 1923, *Clemens 1712:* Pangasinan Province, Rosales and vicinity, February 1 to 14, 1925, *Clemens 5899, 5899a.*

7. **PUCCINIA BRACHYCARPA** Syd.

On *Chamaeraphis squarrosa* (L. f.) Merr., LUZON, Manila, October 2, 1923, *Clemens 1599.*

In his description of this species Sydow [3] did not mention the location of the germ pores in the teliospores. The pore is apical

[3] Ann. Myc. 29 (1931) 148.

in the upper cell but is near the pedicel in the lower cell. Because of the finely sculptured wall and the location of the lower pore this species is especially interesting and distinctive. Few species of *Puccinia* on grasses have such teliospores.

A few urediospores are present in the telia in this collection and a description follows. Urediospores globoid, 18 to 26 by 23 to 27 μ; wall dark chestnut-brown, 2.5 to 3.5 μ thick, closely and finely verrucose-echinulate, the pores 4, equatorial, distinct.

8. **PUCCINIA CITRATA** Syd.

On *Andropogon micranthus,* LUZON, Benguet Subprovince, Mount Pulog, February 25, 1925, *Clemens 5015.* On *Andropogon* sp., LUZON, Benguet Subprovince, Mount Pulog, February 24 to 27, 1925, *Clemens 4979a, 5015a.* On *Ischaemum* sp. ? LUZON, Benguet Subprovince, Baguio, February, 1925, *Clemens 5787.* On *Ischaemum aristatum* L., LUZON, Bulacan Province, Santa Maria, November, 1924, *Clemens 4859.*

9. **PUCCINIA PURPUREA** Cooke.

On *Andropogon* sp., LUZON, Benguet Subprovince, Adouay, February 24, 1925, *Clemens 4977;* Mount Pulog and vicinity, February 24 to 27, 1925, *Clemens 4978b:* Nueva Vizcaya Province, Santa Fe, January 25, 1924, *Clemens 1694.*

10. **PUCCINIA RUFIPES** Diet. Plate 2, fig. 1.

On *Imperata cylindrica* (L.) Beauv., LUZON, Tarlac Province, Tarlac, December, 1924, *Clemens 4875;* Paniqui, January, 1925, *Clemens s. n.:* Pangasinan Province, Rosales and vicinity, February 1 to 14, 1925, *Clemens 5895, 5896.* MINDANAO, Davao Province, Daron, May, 1924, *Clemens 4926.*

11. **PUCCINIA BENGUETENSIS** Syd.

On *Pollinia argentea* Trin., LUZON, Pangasinan Province, Rosales and vicinity, February 1 to 14, 1925, *Clemens 5893.*

12. **PUCCINIA POLLINIAE-QUADRINERVIS** Diet. Plate 2, fig. 2.

On *Pollinia quadrinervis* Hack., LUZON, Benguet Subprovince, Mount Pulog and vicinity, February 24 to 27, 1925, *Clemens 5013;* Baguio Highway, February, 1925, *Clemens 5794.*

The host for *5794* was labeled as possibly being a species of *Andropogon* or *Ischaemum,* but the urediospores (no telia are present) agree so well with this species that the host is listed as above. The rust is similar to *Uredo ischaemi-ciliati* Petch but differs in having closer and more nearly cubical sculpturing on the walls of the urediospores.

13. **PUCCINIA ERYTHROPUS** Diet.

On *Miscanthus sinensis* Anders., LUZON, Benguet Subprovince, Baguio, February 27 and 28, 1925, *Clemens 5115*. On *Miscanthus* sp. ? LUZON, Benguet Subprovince, Baguio, February, 1925, *Clemens 5109*.

14. **PUCCINIA INVENUSTA** Syd.

On *Phragmites vulgaris* (Lam.) Trin. (*P. communis* Trin.), LUZON, Pangasinan Province, Rosales and vicinity, February 1 to 14, 1925, *Clemens s. n.*

Only urediospores are present in this collection. The wall is verrucose-echinulate rather than minutely verrucose, but the specimen agrees closely in other respects.

15. **PUCCINIA CYNODONTIS** Lacroix.

On *Cynodon dactylon* Pers., LUZON, Zambales Province, Castillejos, March, 1924, *Clemens 1725*.

16. **UROMYCES LEPTODERMUS** Syd.

On *Panicum cocospermum* Steud., LUZON, Nueva Vizcaya Province, Dalbergia Springs, April, 1926, *Clemens 18000* (!). On *Panicum flavidum* Retz., LUZON, Tarlac Province, La Paz, December, 1924, *Clemens 4876*. On *Setaria palmaefolia* (Koenig) Stapf, MINDANAO, Todaya, Mount Apo, June 12 to 15, 1924, *Clemens 2135*.

17. **UROMYCES LINEARIS** B. and Br.

On *Panicum patens* L., MINDANAO, Todaya, Mount Apo, June 15 to 17, 1924, *Clemens 2014*. On *Panicum repens* L., LUZON, Isabela Province, Dagan and Cagayan, January 17, 1923, *Clemens 1722:* Bulacan Province, November, 1924, *Clemens 4860*.

18. **UROMYCES PEGLERIAE** Pole Evans. Plate 3, fig. 3.

On *Digitaria chinensis* Nees, LUZON, Benguet Subprovince, Baguio, February, 1925, *Clemens 5793*.

This collection adds an interesting species previously known only from South Africa.

19. **UROMYCES ERIOCHLOAE** Syd. and Butl.

On *Eriochloa ramosa* (Retz.) Ktze., LUZON, Nueva Vizcaya Province, Bambang, January 21, 1924, *Clemens 1706*.

20. **UROMYCES APLUDAE** Syd. and Butl.

On *Apluda mutica* L., LUZON, Isabela Province, Iligan, December 22, 1923, *Clemens 1747:* Tarlac Province, Gerona, January, 1925, *Clemens 4949*.

21. UROMYCES POLYTRIADICOLA sp. nov. Plate 1, fig. 2.

Uredia amphigena, brunnea; paraphyses periphericales, introrsum curvatae, clavatae vel capitatae, 13–17 x 25–35 μ; membrana 1 μ cr., hyalina; urediosporae obovoideae vel globosae, 19–25 x 23–28 μ; membrana 1.5–2 μ cr., cinnamomeo-brunnea, breviter echinulata, poris germ. 3, equatorialibus. Telia amphigena minuta, teliosporae variabiles, globosae vel oblongae, 16–20 x 18–26 μ; membrana 1.5 μ cr., ad apicem 3 vel 4 μ, castaneo-brunnea, levis, pedicelo hyalino, brevi.

On *Polytrias amaurea* (Büse) O. Kuntze, LUZON, Manila, corner of Georgia and Tennessee Streets, January, 1924, *Clemens 4948.*

22. UROMYCES TENUICUTIS McA.

On *Sporobolus indicus* (L.) R. Br., LUZON, Benguet Subprovince, Baguio, February, 1925, *Clemens 5788, 5789.*

23. UREDO OPLISMENI sp. nov.

Uredia hypophylla, minuta, 50–100 μ diam., paraphyses periphericales, introrsum curvatae, 13–18 x 30–45 μ, membrana 3 μ cr., ad apicem 5 μ, brunnea; urediosporae obovoideae, 17–21 x 22–26 μ; membrana 1.5 μ cr., fulva breviter echinulata, poris germ. Obscuris, verisimiliter 4, equatorialibus.

On *Oplismenus undulatifolius* (Ard.) Beauv., LUZON, Benguet Subprovince, Mount Santo Tomas, February 19, 1925, *Clemens 5786.*

Although no telia could be found on this specimen the character of the uredia indicates that the species may belong in the genus *Angiopsora.*

24. UREDO ARTHRAXONIS-CILIARIS P. Henn.

On ? *Arthraxon* sp., LUZON, Benguet Subprovince, between Camp 30 and Baguio, February 27, 1925, *Clemens 5111;* Adouay region, February, 1925, *Clemens 5111a.* On *Arthraxon quartinianus* Merr. (taken from herbarium mounted sheet), LUZON, Ifugao Subprovince, Polis Pass, February 15, 1913, *R. C. McGregor s. n.* The host is uncertain in the two numbered collections, but the rust appears to be as listed here.

25. UREDO ANDROPOGONIS-ZEYLANICI Petch.

On *Andropogon fragilis* R. Br. var. *malayanus* Merr., LUZON, Benguet Subprovince, between Adouay and Camp 42, February 27, 1925, *Clemens 5113.*

26. UREDO OPERTA Syd. and Butl.

On *Coix lachryma-jobi* L., MINDANAO, Todaya, Mount Apo, May, 1924, *Clemens 1980.*

Uredo operta is described as having spores with three equatorial pores, but this specimen has four to six equatorial pores. Other characters, including paraphyses, agree so closely, however, that a new name does not seem justified without a comparison with type material.

27. UREDO AGROSTIDIS sp. nov. Plate 1, fig. 3.

Uredia amphigena, minuta; paraphyses capitatae, hyalinae; urediosporae globosae, 23–27 x 24–30 μ; membrana 2–3 μ cr., pallide flavida, breviter echinulata, poris germ. 6–8, sparsis.

On *Agrostis elmeri* Merr., LUZON, Benguet Subprovince, automobile road, summit of "hairpin," below Camp 30, February 27, 1925, *Clemens 4982.*

ON CYPERACEÆ

28. PUCCINIA CARICIS (Schum.) Wint.

On *Carex filicina* Nees, LUZON, Benguet Subprovince, Mount Pulog, February 25 and 26, 1925, *Clemens 5017.* On *Carex rafflesiana* Boott, LUZON, Benguet Subprovince, Mount Pulog, February 25, 1925, *Clemens 5102.*

29. PUCCINIA CONSTATA Syd.

On *Carex baccans* Nees, LUZON, Benguet Subprovince, Mount Santo Tomas, February 19, 1925, *Clemens 5800.*

30. PUCCINIA OREOPHILA Syd.

On *Carex rafflesiana* Boott, LUZON, Benguet Subprovince, Mount Pulog, February 25 and 26, 1925, *Clemens 5103.*

31. PUCCINIA OBTECTA Peck.

On *Scirpus articulatus* L., LUZON, Tarlac Province, Paniqui, January, 1925, *Clemens 4959:* Ilocos Norte Province, February, 1907, *E. A. Mearns s. n.*

32. PUCCINIA FIMBRISTYLIDIS Arth.

On *Fimbristylis annua* (All.) R. and S., LUZON, Manila, September 18, 1923, *Clemens 1869.* On *Fimbristylis miliacea* Vahl, LUZON, Cagayan Province, Aparri, January 7, 1924, *Clemens 1751:* Tarlac Province, La Paz, December, 1924, *Clemens 4879, 4880.* On *Fimbristylis* sp., LUZON, Bulacan Province, Santa Maria, November, 1924, *Clemens 4858.*

33. **PUCCINIA FUIRENICOLA** Arth. Plate 1, fig. 4.

On *Fuirena ciliaris* (L.) Roxb., LUZON, Cagayan Province, Aparri, January 7, 1924, *Clemens 1748.*

Telia have not previously been known for this species, its assignment to *Puccinia* being on the assumption that when found the telia would conform to those of that genus. Telia are present in this collection, and a description follows.

Telia hypophyllous, subepidermal, brown, with brown subepidermal paraphyses; teliospores (Plate 1, fig. 4) oblong or cylindric, 14 to 19 by 45 to 60 μ, rounded, obtuse or narrowed above, narrowed below; wall 1.5 μ thick at sides, 5 to 12 μ at apex, light chestnut-brown, smooth, pedicel persistent, brownish, one-half to once length of spore.

34. **PUCCINIA LIBERTA** Kern.

On *Eleocharis variegata* Kunth, LUZON, Bulacan Province, Santa Maria, November, 1924, *Clemens 4861.*

Only uredia are present in this collection. The two germ pores are slightly more superequatorial than is typical.

35. **PUCCINIA MYSORENSIS** Syd. and Butl.

On *Kyllinga brevifolia* Rottb., LUZON, Bulacan Province, Sibul Springs, December, 1924, *Clemens 4944.* On *Kyllinga intermedia* R. Br., LUZON, Benguet Subprovince, below Camp 30, Mount Pulog and vicinity, February 24 to 27, 1925, *Clemens 5108;* Mount Santo Tomas, February 19, 1925, *Clemens 5801.*

36. **PUCCINIA PHILIPPINENSIS** Syd.

On *Cyperus rotundus* L., LUZON, Tarlac Province, Paniqui, January, 1925, *Clemens 4964a:* Pangasinan Province, Agno River, Rosales and vicinity, February 1 to 14, 1925, *Clemens 5900, 5923a* (no date). On *Pycreus globosus* (All.) Reichb., LUZON, Benguet Subprovince, below Camp 42, February 27, 1925, *Clemens 5107.*

37. **PUCCINIA ROMAGNOLIANA** Maire and Sacc.

On *Cyperus difformis* L., LUZON, Tarlac Province, near Pura, November, 1923, *Clemens 1864;* La Paz, December, 1924, *Clemens 4878;* Paniqui, January, 1925, *Clemens 4958.*

38. **PUCCINIA SCLERIAE** (Paz.) Arth.

On *Scleria tessellata* Willd., LUZON, Manila, September 18, 1923, *Clemens 1868.* On *Scleria* sp., LUZON, Benguet Subprovince, Mount Santo Tomas, February 19, 1925, *Clemens 5803.*

39. UROMYCES SCIRPINUS Syd.

On *Scirpus erectus* Poir., LUZON, Nueva Vizcaya Province, Bambang, January 21, 1924, *Clemens 1714:* Pangasinan Province, near Mount Balungao Hot Spring, Rosales, February 1 to 14, 1925, *Clemens s. n.*

40. UREDO PERIDIATA sp. nov. Plate 2, figs. 4 and 5.

Uredia hypophylla, minuta, plus minus aequaliter distributa; peridio ex cellulis composito, cellulis cubicis, 11–16 μ, fulva vel hyalina, 1.5–2 μ cr.; urediosporae ellipsoideae vel globosae, 20–28 x 25–35 μ; membrana 1.5 μ cr., pallide fulva vel fere hyalin, dense et breviter echinulata, poris germ. obscuris.

On *Carex rafflesiana* var. *scaberrima* (Boeck.) Kükenth., LUZON, Benguet Subprovince, Mount Santo Tomas, February 19, 1925, *Clemens 5795.*

This is a distinctive species and is unique among the rusts of *Carex* because of its well-developed peridium, which resembles the peridia of some melampsoraceous genera. The peridium opens by apical rupture but appears to lack special ostiolar cells. Near the base of the sorus the cells of the peridium become longer and have thinner walls. The urediospores offer no special features.

Without telia the generic position of this species must remain uncertain, but it seems probable that it is related to *Angiopsora*, a genus not reported as occurring on sedges.

ON COMMELINACEÆ

41. UREDO DAVAOENSIS Syd.

On *Cyanotis axillaris* (L.) R. and S., LUZON, Manila, near San Francisco Church, October 9, 1923, *Clemens 1602.*

ON ARACEÆ

42. PUCCINIA RHAPHIDOPHORAE (Sacc.) Syd.

On *Rhaphidophora Merrillii* Engl., LUZON, Tarlac Province, Gerona, January, 1925, *Clemens 4950.*

ON LILIACEÆ

43. UREDO DIANELLAE Diet.

On *Dianella ensifolia* (L.) DC., LUZON, Benguet Subprovince, Mount Pulog and vicinity, February 24 to 27, 1925, *Clemens 5120.* On *Dianella javanica* (Bl.) Kunth, LUZON, Benguet Subprovince, Mount Santo Tomas, February 19, 1925, *Clemens 5806.*

44. PUCCINIA CITRINA Syd. Plate 3, fig. 2.

On *Smilax* sp., MINDANAO, Mount Apo, Thermal Springs, May 31, 1924, *Clemens 2026, 2027.*

Pycnia but no aecia are present in *2026* which also has abundant uredia and a few teliospores. The urediospores agree with those described for *P. citrina* and the teliospores differ only in having pedicels which are not especially persistent, but since most of them appeared to be rather immature this may not be significant.

Pycnia and aecia are present on *2027*, and because the aeciospores agree with the urediospores of *P. citrina* in the apical thickening of the wall it is considered probable that these aecia belong in the life cycle of *P. citrina.* Both collections were made at the same locality and on the same day. A description of the pycnia and aecia follows.

Pycnia subepidermal, amphigenous, 100 to 150 μ in diameter. Aecia (Plate 3, fig. 2) amphigenous, on slightly hypertrophied veins with the pycnia, deep-seated, with an easily separable peridium; aeciospores oblong or obovoid, 22 to 29 by 30 to 39 μ; wall 2 to 3 μ thick at sides and base, thickened 5 to 12 μ above, colorless or pale yellowish, closely and coarsely verrucose with nearly cubical sculpturing.

45. PUCCINIA MERRILLII P. Henn.

On *Smilax bracteata* Presl, LUZON, Pangasinan Province, Rosales and vicinity, February 1 to 14, 1925, *Clemens 5902.* On *Smilax ? china* L., LUZON, Benguet Subprovince, Adouay, February 24, 1925, *Clemens 4948.*

46. PUCCINIA SMILACIS-CHINAE P. Henn. Plate 3, fig. 1.

On *Smilax china* L., LUZON, Benguet Subprovince, Mount Pulog, February 25, 1925, *Clemens 4983.*

A single uredium was found on this collection and the urediospores corresponded to those of *P. smilacis-chinae.* Pycnia and aecia were also present and are considered to belong with this species. The aecia and aeciospores are large and easily distinguished from those described for *P. citrina.* A description follows.

Pycnia amphigenous, on slightly hypertrophied areas on the veins, petioles and stems, subepidermal, 100 to 200 μ in diameter. Aecia (Plate 3, fig. 1) amphigenous, among the pycnia, deep-seated, with an easily separable peridium; aeciospores oblong, sometimes narrowed above, 23 to 32 by 42 to 60 μ; wall 3 to

5 μ thick at sides and base, thickened 10 to 20 μ above, closely and coarsely verrucose.

The taxonomy of the rusts on *Smilax* appears to need careful study and possible revision. Inoculation experiments would do much to clear up the confusion. The descriptions of aecia given in this paper for *P. citrina* and *P. smilacis-chinae* and the suggestions of the probable relationship of these aecia are made with the hope that botanists located in regions where these species occur may undertake to study their life histories experimentally. In the meantime there would seem to be little advantage in giving specific names under the form-genus *Aecidium*, although the aecia described here can be readily distinguished.

ON DIOSCOREACEÆ

47. UREDO DIOSCOREAE-FILIFORMIS Racib.

On *Dioscorea nummularia* L., MINDANAO, Mount Apo, Todaya, May 27, 1924, *Clemens 1982*.

48. UREDO DIOSCOREAE-SATIVAE Syd.

On *Dioscorea flabellifolia* Prain and Burkill, MINDANAO, Mount Apo, Todaya, May, 1924, *Clemens 2021*. On *Dioscorea hispida* Dennst., MINDANAO, Mount Apo, Todaya, May 26, 1924, *Clemens 1976*.

The collections reported here were found to differ from the published descriptions of species of *Uredo* on *Dioscorea* in having a peridium. The cells are cubical at the top of the peridium but become oblong toward the sides. The wall is about 2 μ thick and somewhat brownish. In most preparations the peridium is so collapsed that it is overlooked but it can be seen in thin sections.

In attempting to identify these collections a specimen of *Uredo dioscoreae-pentaphyllae* Petch was sectioned for study. This collection was made by Petch on *D. pentaphylla* at Kandy, Ceylon, January 12, 1912, and possibly is a part of the type collection. A peridium was also found which agreed with that in the Clemens collections. Sydow [4] considers that Petch's species is the same as his *U. dioscoreae-sativae*, but since he describes no peridium and since we have no specimen of *U. dioscoreae-sativae* for comparison we cannot be certain of the identity of the two fungi upon which these names are based. We accept Sydow's opinion, however, on the assumption that he overlooked the peridium as did Petch.

[4] Mono. Ured. 4 (1924) 514.

The species differs from *Uredo dioscoreae-filiformis* in having smaller, more finely echinulate spores and in the possession of a peridium. *Uredo dioscoreae-alatae* Racib. appears to be similar, but the sori are situated much deeper in the leaf. In the material of this species at our disposal we were unable to distinguish a peridium. These three species appear to be closely related.

ON AMARYLLIDACEÆ

49. PUCCINIA CURCULIGONIS Racib.

On *Curculigo capitulata* (Lour.) Ktze., LUZON, Benguet Subprovince, Santo Tomas, February 19, 1925, *Clemens 5805*. On *Curculigo orchioides* Gaertn., MINDANAO, Davao Province, below Sibulan, May, 1924, *Clemens 4927*.

ON ZINGIBERACEÆ

50. UREDO COSTINA Syd.

On *Costus speciosus* Sm., MINDANAO, Mount Apo, Todaya, June, 1924, *Clemens 1973*.

ON ORCHIDACEÆ

51. COLEOSPORIUM MERRILLII P. Henn.

On *Calanthe furcata* Batem., LUZON, Benguet Subprovince, Baguio, February, 1925, *Clemens 5804*.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Angiopsora Clemensae* Arth. and Cumm., a telium, showing the sessile catenulate teliospores and the compact, subepidermal nature of the sorus; × 650. (Anda, Luzon, March, 1925, *Clemens s. n.*)

2. *Uromyces polytriadicola* Arth. and Cumm., one urediospore and one teliospore; × 650. (*Clemens 4948.*)

3. *Uredo agrostidis* Arth. and Cumm., one of the capitate paraphyses and one urediospore showing the characteristic arrangement of the germ pores and the relatively thick wall; × 650. (*Clemens 4982.*)

4. *Puccinia fuirenicola* Arth., two teliospores; × 650. (*Clemens 1748.*)

PLATE 2

FIG. 1. *Puccinia rufipes* Diet., teliospores; × 500. (Paniqui, Luzon, January, 1925, *Clemens s. n.*)

2. *Puccinia polliniae-quadrinervis* Diet., teliospores; × 500. (*Clemens 5013.*)

3. *Puccinia subcentripora* Arth. and Cumm., one teliospore showing the pore midway to pedicel in the lower cell; × 500. (*Clemens 5898.*)

4. *Uredo peridiata* Arth. and Cumm., a uredium; × 100. (*Clemens 5795.*)

5. *Uredo peridiata* Arth. and Cumm., a section of a uredium showing the cellular peridium situated just beneath the epidermis of the host; × 500. (*Clemens 5795.*)

PLATE 3

FIG. 1. *Puccinia smilacis-chinae* P. Henn., a section of the aecia. The apical thickening of the walls of the aeciospores can be seen in some spores. A single pycnium also shows; × 100. (*Clemens 4983.*)

2. *Puccinia citrina* Syd., a section of an aecium; × 100. (*Clemens 2027.*)

3. *Uromyces pegleriae* Pole Evans, a teliospore; × 500. (*Clemens 5793.*)

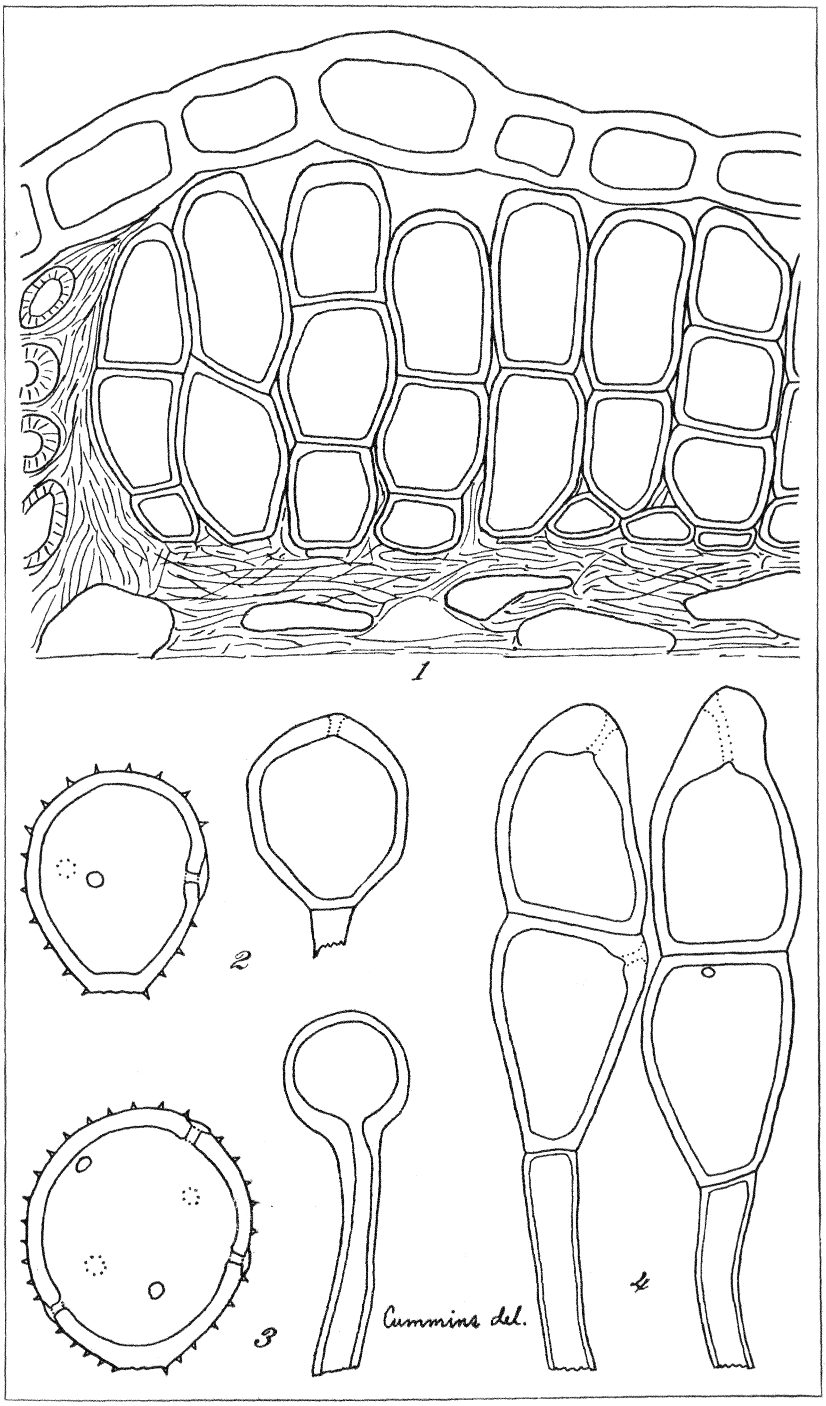

PLATE 1.

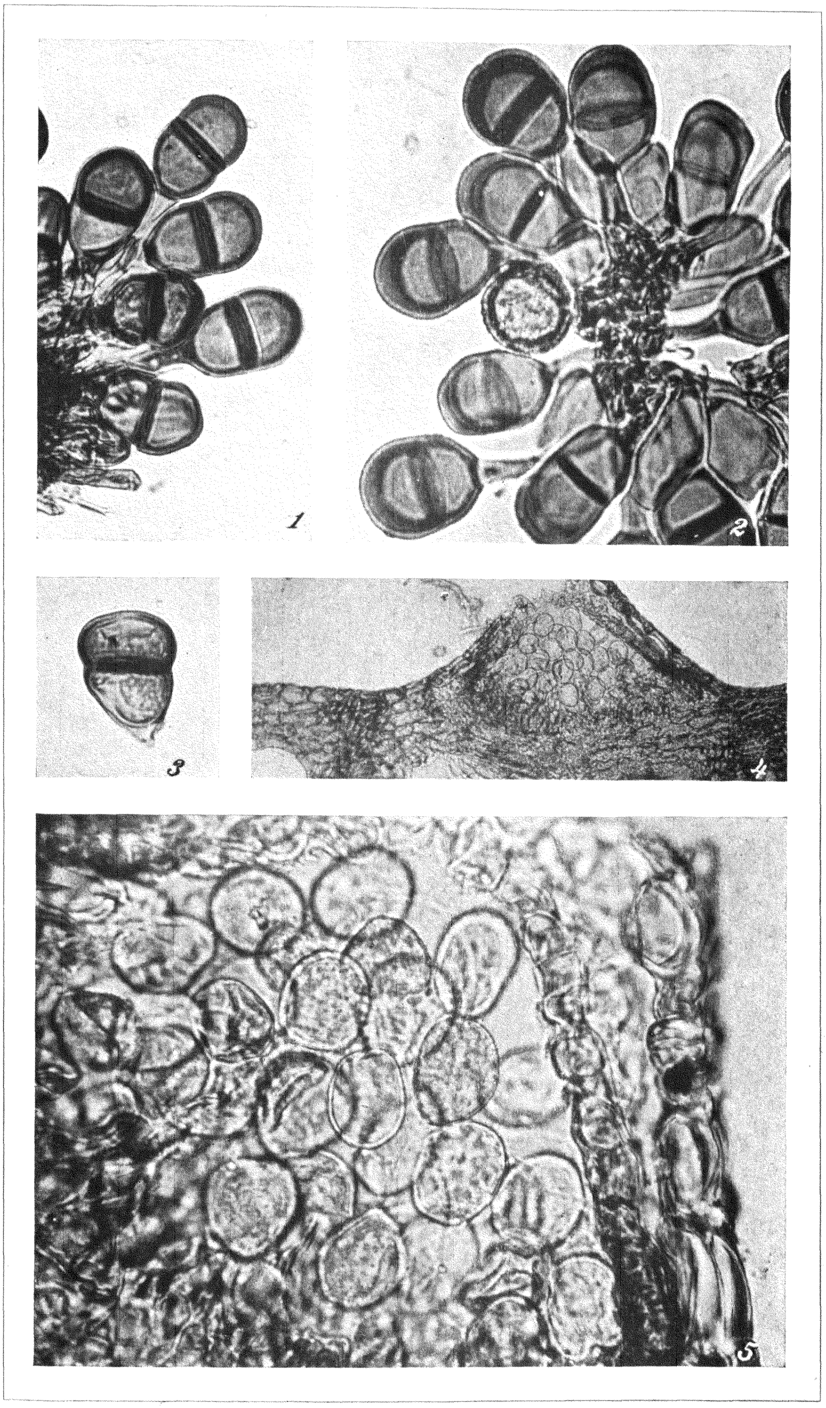

PLATE 2.

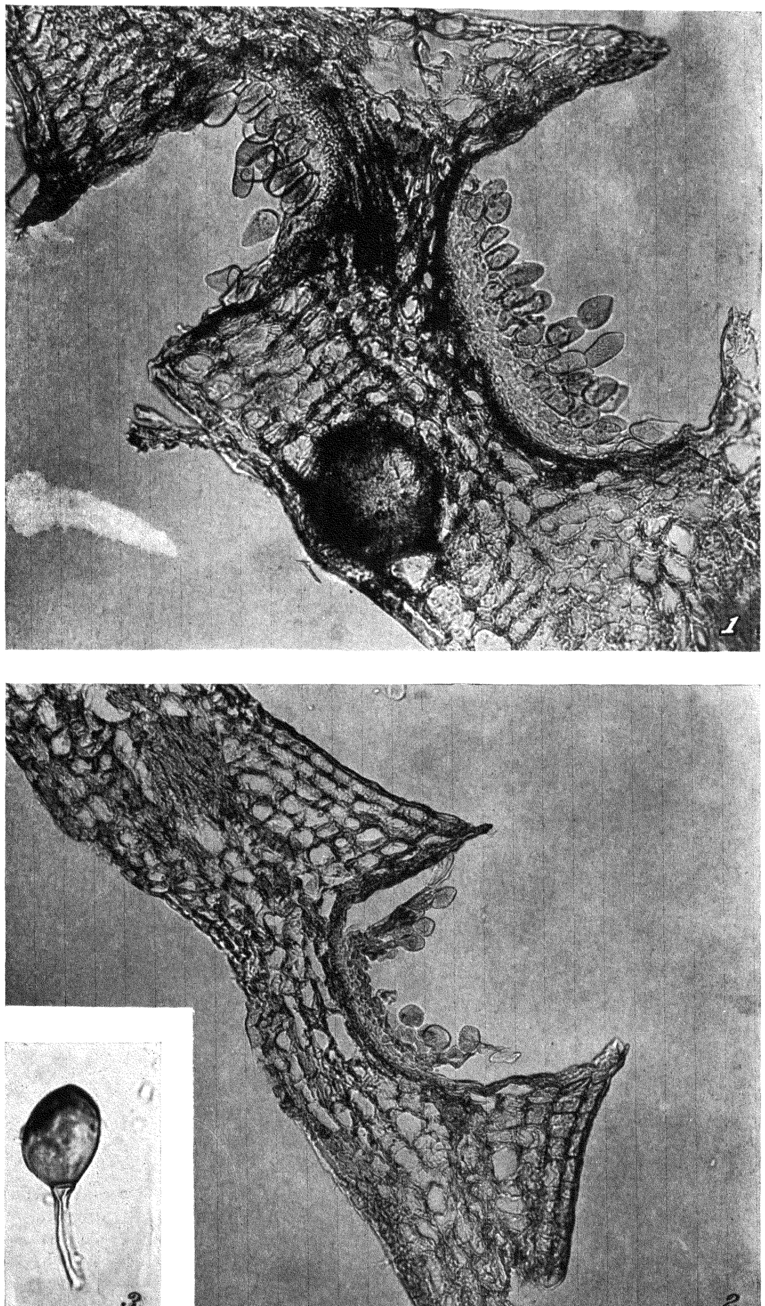

PLATE 3.

THE IDENTITY OF CONVOLVULUS REPTANS LINNÆUS

By E. D. Merrill

Administrator of Botanical Collections, Harvard University, Cambridge

ONE PLATE

In 1910 Hallier f. noted[1] that the actual specimen of *Convolvulus reptans* Linn. in the Linnæan herbarium represents the species interpreted by him as *Merremia caespitosa* (Roxb.) Hall. f., a disposition of the Linnæan species that is totally at variance with the generally accepted application of the Linnæan binomial which has been assumed by most authors to represent the very different *Ipomoea reptans* Poir. (*I. aquatica* Forsk.). The original Linnæan description, reproduced below, clearly indicates that it was based on the specimen now in the Linnæan herbarium and that it represents a species very different from *Ipomoea reptans* Poir.

Convolvulus reptans Linn. Sp. Pl. (1753) 158.

CONVOLVULUS foliis hastato-lanceolatis; auriculis rotundatis, caule repente, pedunculis unifloris. *Ballel* Rheed. mal. II. p. 107, *t. 52.*

Habitat in India.

Planta ex minoribus. Caulis filiformis, nec volubilis. Folia lanceolata, basi auricula utrinque recurvata, obtusa, glabra, angusta, acuminata, petiolis brevissimis insidentia. Pedunculi breves, uniflori. Calyx rotundatus.

The specimen on which the above description was based, so labeled by Linnæus, was in the herbarium in 1753, and Plate 1 represents a photographic reproduction of it.

The current misinterpretation of the Linnæan binomial is due to Linnæus's own error in citing *Ballel* Rheede, Hort. Malabar. 11: 107, *pl. 52,* as representing his species. This illustration is a good representation of *Ipomoea reptans* Poir. = *I. aquatica* Forsk. That Linnæus himself interpreted *Ballel* as representing his species, in spite of the fact that it did not conform at all closely with the characters of the specimen on which his original description was based, is evidenced by his treatment of *Olus vagum* Rumph., Herb. Amb. 5: 419, *pl. 155, fig. 1,* which in 1754, 1759, and 1762 he referred to *Convolvulus reptans;* Rumphius's figure is a good illustration of *Ipomoea reptans* Poir. = *I. aquatica* Forsk.

[1] Med. Rijks Herb. Leiden 1 (1910) 21.

In view of the factors involved the correct interpretation of *Convolvulus reptans* Linn. is as representing a *Merremia,* for those that recognize this genus, but not as representing *Ipomoea reptans* Poir. = *I. aquatica* Forsk. The synonymy of the two species involved is given below.

MERREMIA HIRTA (Linn.) Merr. Plate 1.

Merremia hirta (Linn.) MERR. in Philp. Journ. Sci. Bot. 7 (1912) 244, Enum. Philip. Fl. Pl. 3 (1923) 361.

Convolvulus hirtus LINN., Sp. Pl. (1753) 159; HALL. F. in Meded. Rijks Herb. Leiden 1 (1910) 21.

Convolvulus reptans LINN., Sp. Pl. (1753) 158; HALL. F. in Meded. Rijks Herb. Leiden 1 (1910) 21.

Convolvulus cæspitosus ROXB., Hort. Beng. (1814) 14, *nomen nudum,* Fl. Ind. 2 (1824) 70.

Ipomoea linifolia BLUME, Bijdr. (1826) 721.

Skinneria cæspitosa CHOISY in Mém. Soc. Phys. Hist. Nat. Genève 6 (1833) 487, *pl. 6;* Conv. Or. (1834) 105, *pl. 6.*

Ipomoea philippinensis CHOISY in Mém. Soc. Phys. Hist. Nat. Genève 6 (1833) 475; Conv. Or. (1834) 93.

Ipomoea setulosa ZOLL. and MOR., Syst. Verzeich. (1845) 51.

Ipomoea hepaticifolia BLANCO, Fl. Filip. ed. 2 (1845) 72.

Merremia cæspitosa HALL. F. in Engl. Bot. Jahrb. 16 (1892) 552.

Hallier f., who examined both Linnæan types, states that they represent a single species for which he adopted the name *Merremia caespitosa* (Roxb.) Hall. f. I follow his interpretation of *Merremia caespitosa* as including forms with glabrous and with more or less hairy stems, and with distinctly variable leaf characters as to shape and size. It may be noted that *Convolvulus reptans* Linn. has page priority over *C. hirtus* Linn., but priority of place is not recognized under the International Code of Botanical Nomenclature. This variable species is one of wide geographic distribution, extending from India to southern China, through Malaysia and the Philippines to tropical Australia.

IPOMOEA AQUATICA Forsk.

Ipomoea aquatica FORSK., Fl. Aeg.-Arab. (1775) 44.

Ipomoea reptans POIR. in Lam. Encycl. Suppl. 3 (1814) 460 non *Convolvulus reptans* Linn.

Convolvulus repens VAHL, Symb. 1 (1790) 17.

Convolvulus adansoni LAM., Encycl. 3 (1791) 560.

Ipomoea subdentata MIQ., Fl. Ind. Bat. 2 (1856) 614.

Widely distributed in the Old World Tropics, in southern China commonly cultivated or semicultivated. Throughout its range the young shoots are commonly used as a pot-herb, as are the young shoots of the sweet potato, *Ipomoea batatas* Poir.

ILLUSTRATION

PLATE 1. *Convolvulus reptans* Linn., type specimen in the Linnæan herbarium=*Merremia hirta* (Linn.) Merr.

PLATE 1.

THE PHILIPPINE JOURNAL OF SCIENCE

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The articles in the Philippine Journal of Science are indexed in the International Index to Periodicals, New York, N. Y.

VOL. 59, NO. 4 APRIL, 1936

THE PHILIPPINE JOURNAL OF SCIENCE

MANILA
BUREAU OF PRINTING
1936

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THE PHILIPPINE JOURNAL OF SCIENCE

Published by the Bureau of Science, Department of Agriculture and Commerce

[Entered at the Post Office at Manila, P. I., as second-class matter.]

THE PHILIPPINE JOURNAL OF SCIENCE

VOL. 59 APRIL, 1936 No. 4

EFFECT OF FILTRATION ON THE SANITARY QUALITY OF THE WATER OF THE METROPOLITAN WATER DISTRICT

By P. I. DE JESÙS and J. M. RAMOS

Of the School of Hygiene and Public Health, University of the Philippines Manila

TWO TEXT FIGURES

INTRODUCTION

A filter plant for a public water-supply system has two principal purposes; namely, real, to improve the quality of the water for drinking purposes; and psychological, to inspire and develop public confidence. Just how far the new filter plant of the City of Manila has accomplished the first purpose is the object of our present study. As to the second it can be stated that even at this early period, a large part of our public has begun to utilize the city water for drinking uses with greater confidence.

In a previous investigation,(1) made when the city water supply was not filtered, we showed that the sanitary quality of the water was not always satisfactory at certain times of the year and that chlorination alone was not sufficient to reduce effectively the number of bacteria and to eliminate organisms of the *Bacillus coli-aërogenes* group. We then took the occasion to point out that filtration in addition to chlorination seemed to be the most feasible means of improving the sanitary quality of the water. We were, therefore, very much pleased to find that the Governor-General and other public officials shared the same views and used their good offices in bringing about the immediate completion of the filter plant.

In May, 1935, the filters were operated for the first time, but since the filters were new and many experiments had to be conducted to adjust the dose of chemicals or correct small errors in construction, the first months of filtration should really be considered as a period of experimentation and we have designated it as such in this paper. It was not until July, or two months after, that the filters actually started to function normally and to operate effectively.

The filters of the Metropolitan Water District are of the rapid sand (mechanical gravity) type. The filter plant is located at the junction of the new Novaliches and the old Montalban lines at the barrio of Balara, municipality of Marikina, and at an elevation above the pipe line from Montalban but below that of Novaliches. Consequently, the Novaliches water enters the filter plant by gravity, but the Montalban water is lifted by pumps. The main parts of the filter plant in the order of the flow of water are the following: Two chemical houses where the filter alum is added; a long mixing chamber provided with numerous baffles to assure sufficient agitation of the water (the Montalban water does not pass through this chamber) ; two coagulating or settling basins where part of the "floc" settles; eight filter units of two beds each with a total area of 1,296 square meters; and an open aërator tank where the filtered water is exposed for aëration through nozzles like a series of fountains. The filter plant was designed for a capacity of 40 million gallons per day. It was constructed at a total approximate cost of 1,300,000 pesos and will cost about 120,000 pesos annually to operate.

The filtered water finally passes through an uncovered distributing reservoir located in the municipality of San Juan, 5 kilometers distant, where 0.4 part per million of liquid chlorine is applied before final distribution. However, June 23, 1935, another chlorinator was installed in the filter plant at the outlet of the aërator tank. After this date the dose of chlorine was split into two halves, and 0.2 part per million was applied at the filter plant and 0.2 part per million was added in San Juan.

PROCEDURE OF INVESTIGATION

From September, 1931, to November, 1934, the collection of samples was made on an average of once a week for the raw water of Novaliches and three times a week for the tap water in the city. We intended to collect more frequently, but the

pressure of other duties and the lack of sufficient materials prevented us from doing so. For the same reason we were unable to make the completed tests for the *coli-aërogenes* group of organisms, and reported only the results of presumptive tests after twenty-four hours.

However, in November, 1934, through arrangements made by the Metropolitan Water District, ample help, supplies, and materials were made available for a more intensive study. Therefore, from this date to October, 1935, a period of about one year, a large number of samples from different parts of the metropolitan water system were brought to our laboratory for examination.

During this latter period samples of water were collected twice a day from a tap at the School of Hygiene, and once daily from the different parts of the filter plant, the raw water from Novaliches and Montalban, the San Juan reservoir, and several taps in San Juan, Santa Mesa, Santa Ana, and Tondo. From the other districts of Manila and suburban towns samples were taken twice a week.

In the routine analysis of the sample, the following examinations were included: Bacterial counts per cubic centimeter on agar plates incubated for twenty-four hours at 37° C., tests for organisms of the *coli-aërogenes* group, and measurements of turbidity and residual chlorine. All examinations were made in conformity with the Standard Methods of Water Analysis recommended by the American Public Health Association.(2)

In the tests for the *coli-aërogenes* group we inoculated five 10-cc portions of each sample to lactose-broth fermentation tubes as required in the Drinking Water Standards of the United States Treasury Department Public Health Service.(3) Due to the additional help at our disposal the examinations for the organisms of the *coli-aërogenes* group were performed up to the completed tests. Differentiation of fæcal and nonfæcal organisms was even attempted as time permitted, for which the uric acid and sodium citrate media were employed. It should be mentioned, however, that these differentiation tests are not called for in the bacteriological requirements of the United States Treasury Department standards.

We also made microscopical examinations of the Novaliches raw water and the filtered tap water following the Sedgewick-Rafter method described in the Standard Methods of the American Public Health Association.

RESULTS OF INVESTIGATION

In Table 1 we classified the results of our examinations by months covering the period from November, 1934, to October, 1935, inclusive. We divided the different locations from which samples were collected into eleven groups, as follows: Montalban reservoir, Novaliches reservoir, Balara settling basins, Balara filter effluent, Balara surge tank, Balara aërator, San Juan reservoir, School of Hygiene tap, other city taps, chlorinated suburban taps, and suburban taps receiving only a half dose of chlorine. It must be explained in this connection that the last-mentioned suburban taps received only 0.2 part per million of chlorine from the first chlorinator at the filter plant. This group, however, comprises only a small area in San Juan where the pipe line was tapped above the second chlorinator.

Table 1 also includes a summary of all monthly observations. The average bacterial counts and the percentage positives for the *coli-aërogenes* group of this summary are plotted in text figs. 1 and 2, respectively.

In Table 2 is recorded a summary of the results of the examinations of the city water from September, 1931, to November, 1934, previous to the period covered in Table 1. These were placed in a separate table because of the fewer samples collected and because the examination for the *B. coli-aërogenes* organisms included only presumptive tests after twenty-four hours.

Tables 1 and 2 and text figs. 1 and 2 show that the city water before the completion of the filters, despite continuous disinfection with 0.4 to 0.6 part per million of liquid chlorine, was not always satisfactory for drinking purposes due to the frequent occurrence of organisms of the *coli-aërogenes* group and the irregular bacterial content. However, taking the total of all observations the bacterial counts reached over 100 per cc in only 215, or 18 per cent, of the total of 1,155 samples, and the tests for organisms of the *coli-aërogenes* group were positive in 119, or 2.4 per cent, of 4,859 portions. Although these total percentages for *coli-aërogenes* are low when considered on the basis of the United States Treasury standards, their irregular distribution made the water suspicious at certain months of the year, especially during the rainy season. For example, in November, 1934, 23 per cent of the tests from the School of Hygiene tap and 40 per cent from suburban taps gave positive *coli-aërogenes* tests, thus failing to meet the bacteriological re-

quirements of the United States Treasury Department standards during this particular month.

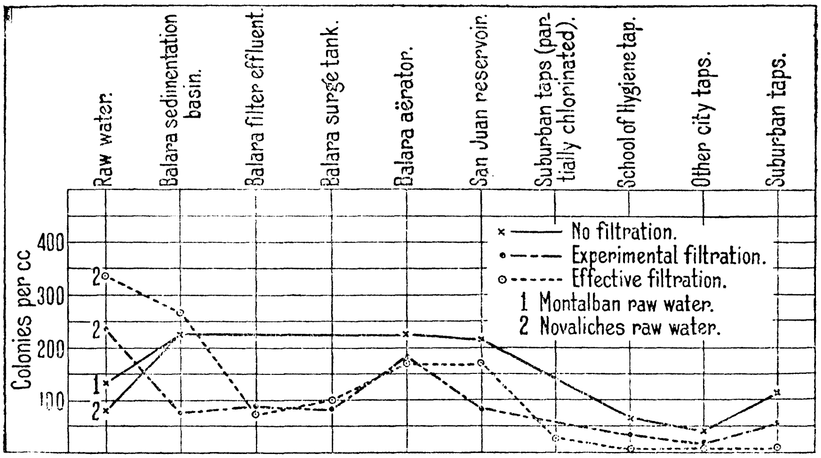

FIG. 1. Average number of bacteria per cubic centimeter in samples collected from different parts of the Metropolitan water system.

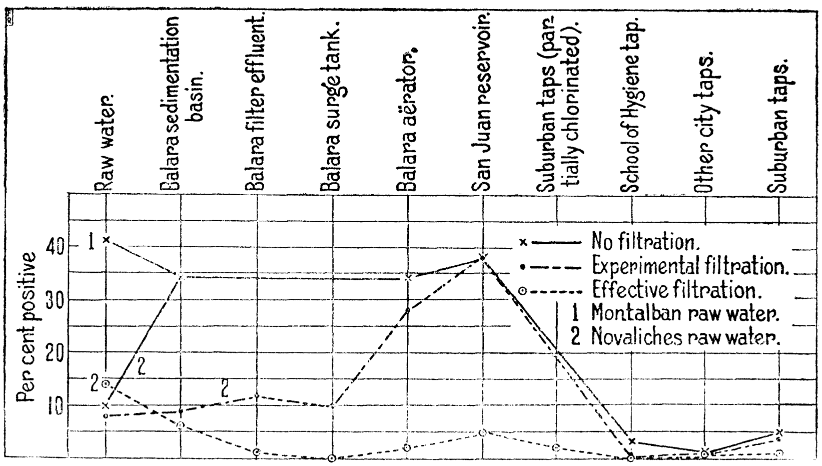

FIG. 2. Percentage positive for *coli-aërogenes* test of samples collected from different parts of the Metropolitan water system.

Furthermore, the turbidity of unfiltered water could not be removed and was quite high during rainy months. It is probable that the poor quality of the Montalban source contributed to the inferior quality of the water before filtration. Table 2 corroborates the findings in Table 1.

The improvement of the city water started even during the experimental filtration period, as shown by the diminution in bacterial counts and positive *coli-aërogenes* tests (Table 1). Thus, during this period only 54, or 9.1 per cent, of 596 samples gave bacterial counts above 100 per cc and only 46, or 1.6 per cent, of 2,962 portions gave positive *coli-aërogenes* tests.

When the filters started to operate effectively, further improvement in the city water is readily noticeable. Thus, in Table 1 it is shown that the bacterial count exceeded 100 per cc in only 15, or 1.1 per cent, of 1,306 samples from chlorinated taps, and 17, or 6.8 per cent, of 249 samples from partially chlorinated suburban taps. The remaining samples with a total of 1,291, or 98.9 per cent, from chlorinated taps and 232, or 93.2 per cent, from partially chlorinated taps gave bacterial counts below 100 per cc, certainly an excellent indication of the good quality of the water. Of even more significance were the tests for the *coli-aërogenes* group in 10 cc portions, which were positive in only 22, or 0.3 per cent, of 6,422 tubes from chlorinated taps; and 5, or 1.9 per cent, of 269 tubes from partially chlorinated suburban taps. No month showed any excess of bacterial counts or positive *coli-aërogenes* beyond the permissible limits. The tap water was visibly clear throughout, the turbidity being lower than 5 parts per million most of the time. The results considered either as a whole or by months are by a large margin within the minimum bacteriological requirements of the United States Treasury Department Public Health Service standards for drinking water. Furthermore, the results become more significant when it is considered that the study was made during the rainy months.

It is to be noted in Table 1 that after aëration there was a slight increase in the bacterial counts and percentage positive for organisms of the *coli-aërogenes* group. They continued to increase at the San Juan distributing reservoir, indicating some pollution at these two points. Both increases, however, were completely overcome by chlorination.

It is interesting to observe the close correlation between the bacterial counts and the tests for the *coli-aërogenes* group. This is more clearly shown in the text figures where parallelism between the curves of the two tests can be readily seen. Thus, low counts were usually accompanied with low percentage positive for the *coli-aërogenes* group and high counts with high percentage positive for *coli-aërogenes*.

Under residual chlorine in Table 1 it will be seen that by and large the residual chlorine found in different parts of the city, except at the School of Hygiene, falls within the desirable limits required by present-day practices. We presume that the failure of the School of Hygiene tap and most of the suburban taps to reach even the minimum limit is due to some peculiarities unknown to us in the layout of the pipe lines. However, the half dose of chlorine given to a few suburban taps already mentioned elsewhere accounts for the findings of very little residual chlorine at these places.

Our microscopical examination of raw water from the Novaliches reservoir, made during December, 1935, revealed the presence of plenty of microörganisms, with an average of 285 per cc. These organisms included plants of the families Chlorophyceæ, Cyanophyceæ, and Diatomaceæ, with predominance of the last group; and protozoan and crustacean animals, of which the protozoan were the more numerous. Cox, Heise, and Gana(4) in similar examinations made in 1913 also reported large numbers of microörganisms in the unfiltered city tap water. It is significant, therefore, that in the examinations of filtered tap water, made on dates coinciding with the same examinations of raw water, only an average of fourteen organisms per cubic centimeter could be recovered, most of which were diatoms. It is probable that these few organisms developed during exposure of the water at the open aërator and brief storage in the uncovered San Juan distributing reservoir where an abundance of sunlight favored the growth and reproduction of the plankton. While our results may point to the efficiency of sand filtration in removing microscopic organisms from water supplies, it also indicates the necessity of covering the aërator and distributing reservoir, which in addition to removing these organisms would prevent possible pollution from malicious or inadvertent sources, especially in times of public disorder and war.

SUMMARY AND CONCLUSION

1. Our study verifies again the superiority of the Novaliches raw water over that of Montalban from the bacteriological point of view, as pointed out in a previous paper.

2. The unfiltered water of either Novaliches or Montalban, even if disinfected with 0.4 to 0.6 part per million of chlorine, was not always satisfactory with regards to its sanitary quality.

3. The filtration of Novaliches water since July, 1935, has markedly improved the quality of the metropolitan water as

shown by low bacterial counts and negative tests for *Bacillus coli-aërogenes* organisms.

4. Close relationship between the colony counts and the tests for *coli-aërogenes* organisms was noted.

5. An increase both in colony counts and percentage positive for *coli-aërogenes* of the filtered water was observed at the open aërator tank and the uncovered San Juan distributing reservoir, which was, however, overcome by chlorination.

6. After filtration the tap water showed no visible turbidity.

7. Microörganisms present in abundance in raw water were markedly reduced in the filtered tap water. These few remaining organisms can probably be removed by covering the aërator and the distributing reservoir.

8. From the results of four months' study of the effects of rapid sand filtration it may be concluded that the city water fully conforms to the standards of the United States Treasury Department Public Health Service for drinking waters. In our opinion the water is safe to drink as long as the Metropolitan Water District keeps up the satisfactory record of performance that it showed during the first four months of filtration.

ACKNOWLEDGMENT

We wish to express our appreciation to Mr. Gregorio Anonas, manager, and Mr. Ambrosio Magsaysay, chief engineer, Metropolitan Water District, for facilitating arrangements that made this study possible. To Mr. Guillermo Abdon, of the same office, we are also grateful for valuable assistance. Finally, we are thankful to our colleagues of the School of Hygiene and Public Health for kindly suggestions.

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TABLE 1.—*Monthly records of laboratory examinations of the Metropolitan Water District water from November, 1934, to October, 1935, showing the effects of filtration.*

BEFORE FILTRATION.

Date.	Location.	Samples.	Average turbidity.	Average residual chlorine.	Colonies per cc after 24 hours at 37° C. Mean.	<100.	>100.	>1,000.	Test for *coli-aërogenes* group. 10-cc portion. Number.	Positive.	1-cc portion. Number.	Positive.
			p. p. m.	p. p. m.		P. ct.	P. ct.	P. ct.		P. ct.		P. ct.
November, 1934	Montalban raw	1			192	0	100	0	5	100		
Do	Balara raw	27			174	41	59	0	103	49		
Do	San Juan reservoir	4			122	50	50	0	20	60		
Do	School of Hygiene tap	28	1.74	0.016	75	82	18	0	60	23		
Do	Other city taps	12		0.018	11	100	0	0	12	0		
Do	Suburban taps	25		0.012	102	64	36	0	25	40		
December, 1934	Montalban raw	7			161	29	71	0	33	100		
Do	Novaliches raw	1			42	100	0	0	3	100		
Do	Balara raw	31			525	52	48	10	150	50		
Do	San Juan reservoir	22			72	71	29	0	103	79		
Do	School of Hygiene tap	41	3.17	0.038	12	100	0	0	205	10		
Do	Other city taps	45		0.292	8	100	0	0	49	6		
Do	Suburban taps	35		0.046	30	89	11	0	35	20		
January, 1935	Montalban raw	21			90	67	33	0	70	46		
Do	Novaliches raw	15			72	73	27	0	39	8		
Do	Balara raw	14			73	86	14	7	70	7		
Do	San Juan reservoir	42			76	90	10	0	138	15		
Do	School of Hygiene tap	49	1.80	0.175	5	100	0	0	245	0		
Do	Other city taps	115		0.422	6	99	1	0	327	0		
Do	Suburban taps	44		0.178	29	93	7	0	136	1		
February, 1935	Montalban raw	23			88	70	30	0	43	33	35	6
Do	Novaliches raw	24			58	87	13	0	24	17	15	7
Do	Balara raw	3			68	67	33	0	3	0	3	0
Do	San Juan reservoir	46			120	54	46	0	50	28	34	12

TABLE 1.—*Monthly records of laboratory examinations of the Metropolitan Water District water from November, 1934, to October, 1935, showing the effects of filtration*—Continued.

BEFORE FILTRATION—Continued.

Date.	Location.	Samples.	Average turbidity.	Average residual chlorine.	Colonies per cc after 24 hours at 37° C.				Test for *coli-aërogenes* group.			
									10-cc portion.		1-cc portion.	
					Mean.	<100.	>100.	>1,000.	Number.	Positive.	Number.	Positive.
			p. p. m.	*p. p. m.*		*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*		*P. ct.*
February, 1935	School of Hygiene tap	45	2.23	0.073	44	91	9	0	225	0	165	0
Do	Other city taps	126		0.321	20	94	6	0	625	0.3		
Do	Suburban taps	60		0.076	71	75	25	0	280	1		
March, 1935	Montalban raw	25			132	76	24	0	121	25	121	3
Do	Novaliches raw	24			64	87	17	0	25	3	25	0
Do	San Juan reservoir	50			153	62	38	0	50	32	50	6
Do	School of Hygiene tap	50	2.92	0.056	148	56	44	0	250	0	250	0.4
Do	Other city taps	147		0.158	82	67	33	0	735	4		
Do	Suburban taps	61		0.046	194	44	56	2	305	4		
April, 1935	Montalban raw	6			380	33	67	17	13	23	13	8
Do	Novaliches raw	14			170	71	29	7	14	0	14	0
Do	San Juan reservoir	34			755	35	65	6	89	34	89	8
Do	School of Hygiene tap	34	2.50	0.059	60	85	15	0	170	0	170	0
Do	Other city taps	95		0.239	79	76	24	0	455	0		
Do	Suburban taps	34		0.086	126	59	41	0	160	5		
May, 1935	Novaliches raw	3			148	67	33	0	3	33	3	0
Do	San Juan reservoir	6			236	0	100	0	18	39	13	0
Do	School of Hygiene tap	6	4.37	0.102	352	17	83	17	30	0	30	0
Do	Other city taps	24		0.217	72	79	21	0	120	0		
Do	Suburban taps	12		0.020	454	25	75	8	60	5		

June, 1935	Novaliches raw	12	2.83		42	100	0	0	17	0	17	0
Do	Balara raw	31			47	97	3	0	78	8	18	0
Do	San Juan reservoir	16			97	75	25	0	48	36	8	25
Do	School of Hygiene tap	12	0.42	0.078	4	100	0	0	60	0		
Do	Other city taps	45	0.17	0.120	9	98	2	0	225	0		
Do	Suburban taps	13	0.00	0.028	32	92	8	0	65	8		

EXPERIMENTAL FILTRATION.

March, 1935	Novaliches raw	2			93	50	50	0	2	0	2	0
Do	Balara sedimentation basin	9			72	78	22	0	13	0	6	0
Do	Balara filter effluent	5			137	60	40	0	25	52	15	0
Do	San Juan reservoir	6			133	50	50	0	6	33	4	25
Do	School of Hygiene tap	3	1.67	0.080	228	0	100	0	15	0	15	0
Do	Other city taps	4		0.262	4	100	0	0	20	0		
Do	Suburban taps	8		0.091	124	50	50	0	40	0		
April, 1935	Novaliches raw	10			508	50	50	10	10	20	10	0
Do	Balara sedimentation basin	32			75	87	13	0	32	19	32	3
Do	Balara filter effluent	8			65	88	12	0	40	47	35	14
Do	Balara aërator	14			269	36	64	7	38	100	38	100
Do	San Juan reservoir	20			132	40	60	0	51	76	51	53
Do	School of Hygiene tap	16	0.02	0.048	124	56	44	0	80	2	80	0
Do	Other city taps	36		0.239	79	83	17	0	180	1		
Do	Suburban taps	30		0.056	105	50	50	0	150	4		
May, 1935	Novaliches raw	42	0.44		255	76	24	2	60	8	60	0
Do	Balara sedimentation basin	83			94	84	16	2	84	11	77	0
Do	Balara filter effluent	142			115	48	52	1	162	6	157	2
Do	Balara surge tank	35	0.00		111	69	31	0	171	19	1	0
Do	Balara aërator	32	0.00		256	23	77	6	152	39	6	17
Do	San Juan reservoir	88			52	83	17	0	264	29	64	2
Do	School of Hygiene tap	49	0.00	0.048	17	96	4	0	241	0	41	0
Do	Other city taps	164	0.10	0.142	8	99	1	0	820	1		
Do	Suburban taps	59	0.17	0.045	68	76	24	0	291	7		

TABLE 1.—*Monthly records of laboratory examinations of the Metropolitan Water District water from November, 1934, to October, 1935, showing the effects of filtration*—Continued.

EXPERIMENTAL FILTRATION—Continued.

Date.	Location.	Samples.	Average turbidity.	Average residual chlorine.	Colonies per cc after 24 hours at 37° C.				Test for *coli-aërogenes* group.			
									10-cc portion.		1-cc portion.	
					Mean.	<100.	>100.	>1,000.	Number.	Positive.	Number.	Positive.
			p. p. m.	*p. p. m.*		*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*		*P. ct.*
June, 1935	Novaliches raw	37	2.50		146	68	32	3	37	5	37	3
Do	Balara sedimentation basin	62	0.56		52	87	13	0	62	5	62	0
Do	Balara filter effluent	145			56	85	15	0	145	1	145	1
Do	Balara surge tank	36			51	89	11	0	175	1		
Do	Balara aërator	32			49	88	12	0	165	2		
Do	San Juan reservoir	50			105	78	22	0	114	30	10	
Do	School of Hygiene tap	37	0.00	0.076	2	100	0	0	185	0		
Do	Other city taps	131	0.00	0.131	6	99	1	0	645	0		
Do	Suburban taps	59	0.00	0.036	9	100	0	0	295	2		

EFFECTIVE FILTRATION.

Date.	Location.	Samples.	Average turbidity.	Average residual chlorine.	Mean.	<100.	>100.	>1,000.	10-cc Number.	10-cc Positive.	1-cc Number.	1-cc Positive.
July, 1935	Novaliches raw	38	5.74		306	18	82	5	40	30	40	17
Do	Balara sedimentation basin	76	2.43		441	37	63	11	79	13	79	3
Do	Balara filter effluent	272	0.25		85	74	26	0.4	265	2	265	0.4
Do	Balara surge tank	42	0.25		205	48	52	7	110	0	25	4
Do	Balara aërator	40	0.25		416	30	70	10	110	3	25	4
Do	San Juan reservoir	61	0.22		484	52	48	13	68	13	58	3
Do	School of Hygiene tap	45	0.23	0.052	9	100	0	0	206	0	1	0
Do	Other city taps	158	0.25	0.101	9	99	1	0	755	0.4		
Do	Suburban taps	108	0.58	0.095	13	98	2	0	521	1	1	0
Do	Suburban taps (partially chlorinated).	62	0.22		68	74	26	0	67	2	57	2

August, 1935	Novaliches raw	31	9.08		522	23	27	13	31	13	31	3
Do	Balara sedimentation basin	76	2.22		309	70	30	9	76	9	76	0
Do	Balara filter effluent	350	0.36		75	82	18	0	350	3	350	0.3
Do	Balara surge tank	33	0.38		72	82	18	0	33	0	33	0
Do	Balara aërator	35	0.35		90	77	23	0	36	6	36	0
Do	San Juan reservoir	61	0.64		100	80	20	2	62	5	62	0
Do	School of Hygiene tap	46	0.56	0.032	4	100	0	0	240	0		
Do	Other city taps	165	0.64	0.141	8	98	2	0	825	1		
Do	Suburban taps	129	0.72	0.129	10	97	3	0	650	1		
Do	Suburban taps (partially chlorinated).	62	0.62		21	98	2	0	61	2	61	0
September, 1935	Novaliches raw	29	5.26		406	7	93	10	29	3	29	0
Do	Balara sedimentation basin	57	2.39		190	35	65	2	57	2	57	2
Do	Balara filter effluent	329	0.57		65	88	12	0	329	0	329	0
Do	Balara surge tank	29	0.58		44	97	3	0	29	0	29	0
Do	Balara aërator	27	0.58		54	96	4	0	27	0	27	0
Do	San Juan reservoir	59	1.23		69	78	22	0	59	2	59	2
Do	School of Hygiene tap	34	1.25	0.020	3	100	0	0	170	0		
Do	Other city taps	155	1.24	0.111	4	100	0	0	775	0		
Do	Suburban taps	128	1.24	0.133	6	99	1	0	640	0		
Do	Suburban taps (partially chlorinated).	63	1.23		12	100	0	0	79	4	59	0
October, 1935	Novaliches raw	31	4.12		120	39	61	0	31	3	31	0
Do	Balara sedimentation basin	66	1.87		83	74	26	0	66	0	66	0
Do	Balara filter effluent	317	0.56		59	93	7	0	317	0	317	0.3
Do	Balara surge tank	31	0.55		46	97	3	0	31	0	31	0
Do	Balara aërator	31	0.55		41	100	0	0	31	0	31	0
Do	San Juan reservoir	62	1.26		21	100	0	0	62	0	62	0
Do	School of Hygiene tap	21	1.29	0.007	2	100	0	0	105	0	0	
Do	Other city taps	175	1.26	0.096	4	99.4	0.6	0	875	0	0	
Do	Suburban taps	132	1.25	0.107	8	98	2	0	660	0.7	0	
Do	Suburban taps (partially chlorinated).	62	1.26		8	100	0	0	62	0	62	0

TABLE 1.—*Monthly records of laboratory examinations of the Metropolitan Water District water from November, 1934, to October, 1935, showing the effects of filtration*—Continued.

SUMMARY.

Date.	Location.	Samples.	Average turbidity.	Average residual chlorine.	Colonies per cc after 24 hours at 37° C.				Test for *coli-aërogenes* group.			
									10-cc portion.		1-cc portion.	
					Mean.	<100.	>100.	>1,000.	Number.	Positive.	Number.	Positive.
			p. p. m.	*p. p. m.*		*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*		*P. ct.*
No filtration	Montalban raw	83	-------	-------	130	64	36	1	285	41	169	4
Do	Novaliches raw	93	2.83	-------	80	83	17	1	125	10	74	1
Do	Balara raw	106	-------	-------	224	67	33	4	404	34	21	0
Do	San Juan reservoir	220	-------	-------	216	62	38	1	516	38	194	8
Do	School of Hygiene tap	265	2.38	0.075	62	84	16	0.4	1245	3	615	0.2
Do	Other city taps	609	0.17	0.259	42	86	14	0	2548	1	-------	-------
Do	Suburban taps	284	0.00	0.074	110	69	31	0.7	1066	5	-------	-------
Experimental filtration	Novaliches raw	91	1.40	-------	235	69	31	3	109	8	86	1
Do	Balara sedimentation basin	186	0.56	-------	75	85	15	1	191	9	177	0.6
Do	Balara filter effluent	300	-------	-------	86	67	33	0.3	372	12	352	3
Do	Balara surge tank	71	0.00	-------	80	79	21	0	346	10	1	0
Do	Balara aërator	78	0.00	-------	172	52	48	0.4	355	28	44	89
Do	San Juan reservoir	164	-------	-------	84	75	25	0	435	38	149	23
Do	School of Hygiene tap	105	0.09	0.060	34	89	11	0	521	0.4	136	0
Do	Other city taps	335	0.05	0.148	15	97	3	0	1665	0.7	-------	-------
Do	Suburban taps	156	0.08	0.046	56	79	21	0	776	4	-------	-------
Effective filtration	Novaliches raw	129	6.16	-------	336	22	78	7	131	14	131	6
Do	Balara sedimentation basin	275	2.20	-------	266	55	45	6	278	6	278	1
Do	Balara filter effluent	1268	0.47	-------	71	85	15	0.1	1261	1	1261	0.2
Do	Balara surge tank	135	0.42	-------	101	78	22	2	203	0	118	0.8
Do	Balara aërator	134	0.41	-------	168	72	28	3	204	2	119	0.8
Do	San Juan reservoir	243	0.86	-------	169	78	22	4	251	5	241	1

Do	School of Hygiene tap	146	0.83	0.031	5	100	0	0	721	0	1	0
Do	Other city taps	663	0.94	0.112	6	99	1	0	3230	0.2	0	
Do	Suburban taps	497	1.01	0.117	9	98	2	0	2471	0.6	1	0
Do	Suburban taps (partially chlorinated).	249	0.84		27	93	7	0	269	2	239	0.4

TABLE 2.—*Summary of laboratory examinations of the unfiltered Metropolitan Water District water from September, 1931, to November, 1934.*

Month.	Source.	Samples.	Average turbidity.	Average residual chlorine.	Colonies per cc after 24 hours at 37° C.				Test for *coli-aërogenes* group.					
									10-cc portion.			1-cc portion.		
					Mean.	<100.	>100.	>1,000.	Number.	Positive.	Doubtful.	Number.	Positive.	Doubtful.
			p. p. m.	p. p. m.		P. ct.	P. ct.	P. ct.		P. ct.	P. ct.		P. ct.	P. ct.
January	Novaliches raw	2	5.00		36	100	0	0	2	0	50	2	50	0
Do	School of Hygiene tap	20	0.77	0.006	5	100	0	0	20	0	15	20	0	5
February	Novaliches raw	2	5.00		2	100	0	0	2	0	0	2	0	0
Do	School of Hygiene tap	17	0.00	0.013	3	100	0	0	17	0	6	17	0	6
March	Novaliches raw	1	20.00											
Do	School of Hygiene tap	18	0.00	0.009	5	100	0	0	17	0	0	17	0	0
April	Novaliches raw	1	5.00											
Do	School of Hygiene tap	16	0.00	0.012	17	100	0	0	13	8	15	15	20	7
May	Novaliches raw	3	1.67		53	100	0	0	1	0	0	1	0	0
Do	School of Hygiene tap	22	0.00	0.007	26	95	5	0	20	35	5	20	5	20
June	Novaliches raw	1	5.00		96	100	0	0	1	0	0	1	0	0
Do	School of Hygiene tap	20	0.00	0.004	25	100	0	0	19	32	5	18	6	6
July	Novaliches raw	1	5.00		57	100	0	0	1	0	100	1	0	100
Do	School of Hygiene tap	21	0.48	0.005	13	95	5	0	21	5	14	13	0	8
August	Novaliches raw	2	5.00		8	100	0	0	1	0	100	1	0	0
Do	School of Hygiene tap	28	0.00	0.010	13	100	0	0	27	11	7	15	0	0

TABLE 2.—*Summary of laboratory examinations of the unfiltered Metropolitan Water District water from September, 1931, to November, 1934*—Continued.

Month.	Source.	Samples.	Average turbidity.	Average residual chlorine.	Colonies per cc after 24 hours at 37° C.				Test for *coli-aërogenes* group.					
									10-cc portion.			1-cc portion.		
					Mean.	<100.	>100.	>1,000.	Number.	Positive.	Doubtful.	Number.	Positive.	Doubtful.
			p. p. m.	*p. p. m.*		*P. ct.*	*P. ct.*	*P. ct.*		*P. ct.*	*P. ct.*		*P. ct.*	*P. ct.*
September	Novaliches raw	4	5.00	----	----	----	----	----	----	----	----	----	----	----
Do	School of Hygiene tap	31	2.40	0.007	9	100	0	0	28	0	0	12	0	0
October	Novaliches raw	5	5.00	----	76	50	50	0	4	75	25	4	50	0
Do	School of Hygiene tap	52	2.30	0.011	11	100	0	0	50	2	20	24	0	8
November	Novaliches raw	3	3.33	----	19	100	0	0	3	67	33	3	0	33
Do	School of Hygiene tap	31	1.36	0.012	5	100	0	0	31	10	19	20	0	15
December	Novaliches raw	1	5.00	----	34	100	0	0	1	100	0	1	100	0
Do	School of Hygiene tap	16	0.00	0.004	10	94	6	0	16	12	19	16	12	12
Summary	Novaliches raw	26	5.00	----	43	88	12	0	16	37	83	16	25	12
Do	School of Hygiene tap	292	0.84	0.009	12	99	1	0	279	9	11	207	3	8

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Average number of bacteria per cubic centimeter in samples collected from different parts of the Metropolitan water system.
2. Percentage positive for *coli-aërogenes* tests of samples collected from different parts of the Metropolitan water system.

PHYSICOCHEMICAL FACTORS IN ANOPHELINE ECOLOGY, I: STUDIES ON NITROGEN

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INTRODUCTION

That the physical characters of water influence mosquito breeding has been demonstrated by a large number of investigators, among whom were Leicester,(1) Daniels,(2) Watson,(3) Hacker,(4, 5) Lamborn,(6) Iyengar,(7) Senior-White,(8, 9) MacGregor,(10, 11) Barber and Komp,(12) Purdy,(13) Boyd,(14) and Morin and Bader.(15, 16) These investigators have made precise measurements of the physical characteristics of mosquito breeding places, whereas previously such observations were made only through the naked eye, which naturally lacked the desirable accuracy. They also contributed important data towards the advancement of biological control of malaria.

Of the authors mentioned above I wish to cite especially the following: Watson, in his comprehensive publication on malaria prevention,(3) pointed out the importance and need of the study of the physical properties of mosquito breeding places and substantiated his discussions by observations in the field. Lamborn's study in Malaya(6) gives a good summary of the work on the subject of physical factors in mosquito ecology to the end of 1921. His experiments, though incomplete, attracted much attention to the subject. Senior-White(8) summarized the work published to the end of 1925, and made an intensive study based on seven hundred observations. He was able to define the optimum limits of larva preference to pH range and solute concentration, but was unable to show a sharply limiting factor for saline ammonia and dissolved oxygen. Furthermore, he confirmed the "Association-Limit" hypothesis of Hacker. Finally, he observed the feeding association of certain mosquitoes, especially anophelines, with certain algæ.

In his second paper on the subject Senior-White(9) observed that various investigators recorded wide natural ranges of pH

for a number of anopheline species, and that an abundance of larvæ had been found at widely differing extremes. He concluded that pH alone was not a cause appreciably and directly affecting anopheles larvæ within their ordinary range of variation and could not explain mosquito breeding preference. Barber and Komp,(12) working in Alabama, came to the same conclusions.

Lamborn(6) noted that certain types of female mosquitoes were influenced in their choice of breeding place by odors characteristic of various spots. These odors might be those of certain rotting leaves, fetid rice fragments, malodorous sewage, and other odors, which could not be detected by the human power of smell. He showed that the females of certain species were attracted by the presence of certain kinds of plankton.

Purdy,(13) in an investigation of California rice fields, observed the practical absence of mosquito breeding in one particular rice field, when the surrounding collections of water and other rice fields showed breeding. Comparison of this rice field with the others did not indicate any essential difference in number of larval enemies, relative amount of food supply, temperature, alkalinity of water, free carbon dioxide (CO_2), dissolved oxygen, or relative stability. On the other hand, a heavy growth of a blue-green alga (*Tolypothrix*) in this rice field, found only in rare instances and in minute quantities in the others, seemed to be the factor inhibiting mosquito breeding.

Boyd,(14) working on the physical and chemical factors in relation to the distribution of larvæ in northeastern North Carolina, found that the temperature, light, dissolved oxygen, and carbon dioxide were important factors in determining the distribution of the breeding places of anopheles. He observed that the breeding of *Anopheles quadrimaculatus* and *A. crucians* did not become widespread until available places had a mean temperature of 21° C. or higher, and declined as the temperature went below this limit in the fall. He could find no breeding in waters devoid of dissolved oxygen. *Anopheles quadrimaculatus* appeared to favor water with a fairly high concentration of carbon dioxide. On the other hand, *A. punctipennis* was found in waters having as wide a range in the amount of this gas in solution, but apparently did not show the same degree of predilection for higher concentrations as did *A. quadrimaculatus.*

The literature above cited is by no means a complete enumeration of the studies made on physical factors, as it is realized

that many more investigations have been conducted on this subject.

On the chemical composition of mosquito breeding places, however, very few investigations have been reported. Among these, it is interesting to note that Waddell,(17) in 1903, discovered that minute amounts of ammonia were fatal to mosquito larvæ. He observed that a solution of 1 in 4,000 of liquor ammonia proved fatal to mature larvæ and computed that the presence in water of such minute quantities as 1 in 20,000 or 30,000 would be prohibitive to the life of the newly hatched. His experiments indicated that ammonia is poisonous to mosquito larvæ in all its combinations, the nitrogen unit being the index of effectiveness. Unfortunately, this original finding of Waddell had been overlooked for many years until it was rediscovered by Senior-White in 1927.(18)

Lamborn,(6) through the help of Mr. R. W. Blair, chemist, made preliminary analyses of samples of water collected from a swamp and a pond where *A. aconitus* was absent. Lamborn's study tends to indicate that amounts of less than 1 part per million of albuminoid ammonia were inhibitory to the breeding of *A. aconitus,* but his experiments were not continued far enough to warrant definite conclusions.

Senior-White,(8) in his first study on physicochemical factors affecting mosquito breeding, attempted to determine the ammonia-toleration limits of the different types of anopheles in India, but was not successful, due to the difficulties encountered with the use of the direct Nesslerization method for detecting ammonia. However, in a second paper(9) he reported that albuminoid ammonia had no effect on mosquito breeding, but noted that saline ammonia was inhibitory to anopheline breeding, except in the case of the *rossi* group, in amounts exceeding 1 part per million. He remarked that the increase in saline ammonia resulted when saprophytic organisms, engaged in reducing protein substances to ammonia, were acting at a greater rate than the nitrifying organisms. He concluded that the inhibitory effect of small amounts of ammonia to breeding points to the possibility of a practical biological control by the employment of a bacteriophage to inhibit the growth of *Nitrosomonas,* thereby raising the ammonia content of waters to a lethal figure. On the other hand, Waddell(17) would effect the increase of ammonia by the use of leguminous plants in agricultural rotations.

Williamson,(19) in an extensive study of the subject, showed that correlations existed between certain organic factors and anopheles breeding. Williamson showed that each species had its range of tolerance, though the limit was not determined definitely. His paper also included a summary of previous studies on the effect of mineral salts on anopheles breeding. According to him these studies tend to show that certain mineral factors, as varying concentration of chlorides, phosphates, magnesium, and iron, exerted a certain influence, though not exactly a definable one, except in the case of salinity and iron content, upon the breeding of certain species of mosquitoes. He confirmed the findings of previous workers that iron salts in high concentrations were detrimental to anopheles larvæ.

Williamson,(20) in another publication, explained that the chemical factors detrimental to mosquito larvæ probably operate largely through determining the quality of the food, as this is modified by antecedent occurrences in the nitrogen cycle. He pointed to the possibility that the ratio between the oxidized and ammoniacal nitrogen, which he called nitrification ratio, is responsible for the inhibitory effect upon the anopheline larvæ. The inhibiting effect is obtained when the ratio is less than one. He suggested that consideration of ratios of a group of important causal factors may be more important than taking each of them singly.

Rudolfs and Lackey,(21) in a study of aëdes and culex mosquitoes, made an extensive examination, lasting for several years, for the pH, carbon dioxide, HCO_3, carbonate, chloride, sulphate, free ammonia, albuminoid ammonia, total nitrogen, carbon, aluminium, and iron in two pools: One where supposedly no breeding would take place, and the other a typical woodland pool where continuous breeding of *Aëdes canadensis* occurred. The authors concluded that *A. canadensis* was present in the pool with either high or low total acidity, with free carbon dioxide of 4 and 40 parts per million with 5 and 75 parts per million chlorides, with 2 and 112 parts per million sulphates, with high and low acid carbonates, free ammonia, and albuminoid ammonia. Their finding showed that the carbon-nitrogen ratios of the water did not seem to affect breeding. Larvæ of *C. pipiens* were killed when the reaction of natural water was changed gradually.

In another publication Senior-White(18) reported that the pH, conductivity, carbonates, and albuminoid ammonia were useless

in connection with mosquito breeding. However, he reserved his opinion on the "residual pH," phosphates, and dissolved oxygen, which need further study. He reported that saline ammonia was inhibitory to anopheline breeding, except in the case of the *rossi* group, in amounts exceeding 1 part per million.

From the review of the literature on the subject it seems that explanations and conclusions on the influence of chemical factors on mosquito ecology are still speculative, due to the meagerness of the work done so far. Therefore, it seems that further investigation and research are needed to throw more light on this important subject.

PROCEDURE OF INVESTIGATION

Our investigation deals principally with the examination of some physical and chemical factors affecting the breeding of *Anopheles minimus* var. *flavirostris* and the associated moving-water group of anopheles. The purpose of my present paper is first to determine the natural composition of typical breeding places of *A. minimus*. Later I hope to find the breeding preference of this mosquito for different types of water, and whether or not the varying composition of waters has any influence upon its breeding. If possible I intend to determine the approximate toleration-limit of *A. minimus* to the various chemical constituents of water. *Anopheles minimus* was chosen for this study because it was found by Manalang(22) to be the most efficient vector of malaria in the Philippines.

The first part of my study was confined mostly to Bayan Creek, a typical *minimus* breeding place in the town of San Jose (100 meters' elevation), Bulacan Province, Luzon. This creek is small, sluggish, and tortuous, and changes markedly its cross section and speed at frequent intervals of its course. During the dry months of April and May it has a mean discharge of 0.15 cubic feet per second, but during the rainy months, from July to October, its mean discharge increases to 15 cubic feet or more per second. Its average width at points of observation is from 5 to 7 feet during the dry months, but this is increased to about 7 to 11 feet during heavy rains. It has a mean depth of 0.5 foot during the dry months and 2 feet during the rainy season. My previous study(23) showed that *Anopheles minimus* larvæ were found in portions of the creek with a velocity range, 1 foot from the shore, of from 0.05 to 0.55 foot per second.

Bayan Creek was covered by a variety of vegetation along the edges, notable among which was a species of grass (*Paspalum conjugatum* Berg.) whose leaves overhung the water and afforded good shelter for larvæ. The débris along the creek consisted of roots, twigs, and decaying leaves of bamboo and various trees and shrubs.

In many parts of the creek the banks were steep, and in some places overhanging. *Anopheles minimus* was found in abundance along the edges of these banks, especially where a small amount of shade was afforded by bamboo or other trees. In most places sand and gravel were found at the bottom of the creek, but in those portions frequented by carabaos a thin layer of mud was found at the bottom. No control measure was used on the creek during our experiments.

Besides the samples from Bayan Creek a few samples of water were also collected from other *minimus* breeding places in Los Baños and Calauan, Laguna Province, and in Anabo, Cavite Province. In the latter place stagnant pools by the sides of the stream were examined because they were occasionally found positive for *A. minimus* larvæ.

A number of stations along the breeding place were selected for observation. In each station samples of water were taken, the description was recorded, and the temperature of the water noted. The collections for larvæ were made on an average of five dips, with a dipper holding 800 cubic centimeters. All larvæ collected were counted and identified.

The samples of water were examined immediately in the laboratory in Manila, but when they could not be examined upon arrival they were placed in a refrigerator until the next day. For the purpose of this study I included the examinations for turbidity, ammonia and albuminoid nitrogen, nitrite and nitrate nitrogen, chloride, total iron, dissolved oxygen, and carbon dioxide. Observations from the same station were made weekly during the first three months, later at an average of once every two weeks.

In the analyses for the ammonia and albuminoid nitrogen the distillation method was employed, following the procedure recommended in the Standard Methods of Water Analysis of the American Public Health Association.(24) My analyses for turbidity, nitrite, nitrate, chloride, and total iron conform to the same Standard Methods and all results were recorded in parts per million. Only chemically pure chemicals obtained from re-

liable drug manufacturers abroad were utilized in the analyses. Solutions of these chemicals were renewed from time to time. Before the analyses were started, the samples were filtered in cotton to remove large suspended objects, as leaves, débris, larvæ, etc.

RESULTS AND DISCUSSION

For the sake of clearness I am reporting the results of the present study in several papers. Only the findings on the nitrogen content of natural breeding places of *Anopheles minimus* and associated anopheles are included in this report. The results on chlorides, iron, and other physicochemical factors related to anopheles breeding will be treated in succeeding papers.

A summary of the results of analyses of about 170 samples of water for different forms of nitrogen is found in Tables 1 to 6. Table 1 shows the occurrence and intensity of anopheline breeding in different concentrations of ammonia nitrogen. It will be seen that most of the observations for *A. minimus* occur on breeding places with concentrations of 0.025 or below to 0.124 part per million of ammonia nitrogen and the greatest abundance of larvæ was found within these concentrations.

In Table 2 it will be noted that *A. minimus* occurred mostly in concentrations of 0.050 to 0.349 part per million of albuminoid nitrogen. In Table 3 it will be observed that most of the samples were between concentrations of 0.0 to 0.0079 part per million of nitrite nitrogen, and in Table 4 between 0.010 and 0.049 part per million of nitrate nitrogen. These figures give the natural range of saline concentration at various points during different times. They do not necessarily mean toleration limits for *A. minimus,* inasmuch as even in the maximum concentrations encountered in this study, *A. minimus* was found breeding.

The four tables show that *A. barbirostris* was the most constant associate of *A. minimus,* in Bayan Creek at least. The tables also give the occurrence and abundance of *A. barbirostris* and other anopheles commonly associated with *A. minimus* in relation to different concentrations of nitrogenous substances.

Table 5 records the mean concentrations of different forms of nitrogen in typical *A. minimus* breeding places of Bulacan, Laguna, and Cavite in different months and years included in this study. Table 6 is a summary of Table 5. These tables show that natural breeding places of *A. minimus* give low concentrations of nitrogen, characteristic of those found in unpolluted natural surface waters. An exception is found in the

TABLE 1.—*Occurrence and intensity of anopheline breeding in different concentrations of ammonia nitrogen.*

Ammonia nitrogen in part per million.	*Anopheles minimus.*			*Anopheles barbirostris.*			*Anopheles aconitus.*		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*	
0.000–0.024	14	50	1.26	14	64	1.56	14	29	0.20
0.025–0.049	28	79	1.12	28	61	1.27	28	14	0.03
0.050–0.074	20	90	1.99	20	80	1.20	20	10	0.09
0.075–0.099	12	92	0.77	12	82	1.27	12	9	0.02
0.100–0.124	6	67	1.33	6	67	0.33	6	33	0.07
0.125–0.149	3	33	0.13	3	100	0.67	3	0	0.00
0.150–0.174	2	100	0.50	2	100	0.60	2	0	0.00
0.175–0.199	1	100	0.30	1	100	0.20	1	0	0.00
0.200–0.224	1	100	0.60	1	100	1.00	1	0	0.00
0.225–0.249	2	100	4.50	2	50	0.10	2	0	0.00
0.250–0.274									
0.275–0.299	1	100	10.00	1	100	0.60	1	0	0.00
0.300–0.324	2	50	1.50	2	50	0.40	2	0	0.00
0.325–0.349									
0.350–0.374	2	100	0.50	2	50	0.30	2	50	0.10

Ammonia nitrogen in part per million.	*Anopheles vagus.* Observations. Total.	*Anopheles vagus.* Observations. Positive.	*Anopheles vagus.* Average larvæ per dip.	*Anopheles fuliginosus.* Observations. Total.	*Anopheles fuliginosus.* Observations. Positive.	*Anopheles fuliginosus.* Average larvæ per dip.	Unidentified. Observations. Total.	Unidentified. Observations. Positive.	Unidentified. Average larvæ per dip.	All species. Observations. Total.	All species. Observations. Positive.	All species. Average larvæ per dip.
		P. ct.			*P. ct.*			*P. ct.*			*P. ct.*	
0.000–0.024	14	21	0.06	14	14	0.09	14	57	0.76	14	79	3.93
0.025–0.049	28	0	0.00	28	4	0.01	28	64	0.50	28	89	2.93
0.050–0.074	20	15	0.05	20	0	0.00	20	75	1.05	20	95	4.38
0.075–0.099	12	9	0.13	12	0	0.00	12	64	1.21	12	100	3.40
0.100–0.124	6	0	0.00	6	0	0.00	6	50	0.73	6	67	2.46
0.125–0.149	3	0	0.00	3	0	0.00	3	67	0.93	3	100	1.73
0.150–0.174	2	0	0.00	2	0	0.00	2	100	0.60	2	100	1.70
0.175–0.199	1	0	0.00	1	0	0.00	1	0	0.00	1	100	0.50
0.200–0.224	1	0	0.00	1	0	0.00	1	100	0.40	1	100	2.00
0.225–0.249	2	0	0.00	2	0	0.00	2	100	1.40	2	100	6.00
0.250–0.274												
0.275–0.299	1	0	0.00	1	0	0.00	1	100	10.80	1	100	21.40
0.300–0.324	2	0	0.00	2	0	0.00	2	50	0.50	2	100	2.40
0.325–0.349												
0.350–0.374	2	0	0.00	2	0	0.00	2	50	2.80	2	100	3.70

TABLE 2.—*Occurrence and intensity of anopheline breeding in different concentrations of albuminoid nitrogen.*

Albuminoid nitrogen in part per million.	*Anopheles minimus.* Observations. Total.	*Anopheles minimus.* Observations. Positive.	*Anopheles minimus.* Average larvæ per dip.	*Anopheles barbirostris.* Observations. Total.	*Anopheles barbirostris.* Observations. Positive.	*Anopheles barbirostris.* Average larvæ per dip.	*Anopheles aconitus.* Observations. Total.	*Anopheles aconitus.* Observations. Positive.	*Anopheles aconitus.* Average larvæ per dip.
		P. ct.			*P. ct.*			*P. ct.*	
0.050–0.099	11	45	0.80	11	45	0.80	11	9	0.02
0.100–0.149	19	84	1.20	19	90	1.74	19	37	0.24
0.150–0.199	22	77	1.77	22	64	1.44	22	9	0.03
0.200–0.249	14	100	2.87	14	79	0.97	14	14	0.03
0.250–0.299	18	72	0.80	18	50	0.64	18	6	0.01
0.300–0.349	6	83	1.40	6	50	0.20	6	0	0.00
0.350–0.399	1	100	1.60	1	100	0.20	1	0	0.00
0.400–0.449									
0.450–0.499	1	0	0.00	1	100	0.40	1	0	0.00
0.500–0.549	1	100	0.40	1	100	1.40	1	0	0.00
0.550–0.599	2	100	1.00	2	100	1.80	2	0	0.00
0.600–0.699	1	0	0.00	1	0	0.00	1	0	0.00
0.700–0.799	2	0	0.00	2	50	0.80	2	0	0.00
0.800–0.899	1	100	0.60	1	100	0.60	1	100	0.20
0.900–0.999	1	0	0.00	1	0	0.00	1	0	0.00

Albuminoid nitrogen in part per million.	*Anopheles vagus.*			*Anopheles fuliginosus.*			Unidentified.			All species.		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*			*P. ct.*	
0.050–0.099	11	18	0.04	11	0	0.00	11	36	0.54	11	55	2.20
0.100–0.149	19	16	0.12	19	0	0.00	19	74	0.71	19	100	4.01
0.150–0.199	22	5	0.01	22	9	0.03	22	82	1.56	22	95	4.84
0.200–0.249	14	7	0.04	14	7	0.06	14	86	1.67	14	100	5.64
0.250–0.299	18	0	0.00	18	0	0.00	18	39	0.38	18	83	1.83
0.300–0.349	6	17	0.03	6	0	0.00	6	50	0.97	6	100	2.60
0.350–0.399	1	0	0.00	1	0	0.00	1	100	0.80	1	100	2.60
0.400–0.449												
0.450–0.499	1	0	0.00	1	0	0.00	1	100	0.60	1	100	1.00
0.500–0.549	1	0	0.00	1	0	0.00	1	100	2.20	1	100	4.00
0.550–0.599	2	0	0.00	2	0	0.00	2	100	1.20	2	100	4.00
0.600–0.699	1	0	0.00	1	0	0.00	1	0	0.00	1	0	0.00
0.700–0.799	2	0	0.00	2	0	0.00	2	0	0.00	2	50	0.80
0.800–0.899	1	0	0.00	1	0	0.00	1	0	0.00	1	100	1.40
0.900–0.999	1	0	0.00	1	0	0.00	1	0	0.00	1	0	0.00

TABLE 3.—*Occurrence and intensity of anopheline breeding in different concentrations of nitrite nitrogen.*

Nitrite nitrogen in part per million.	*Anopheles minimus.*			*Anopheles barbirostris.*			*Anopheles aconitus.*		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*	
0.0000–0.0019	20	60	1.41	20	65	1.54	20	15	0.05
0.0020–0.0039	17	82	1.23	17	71	1.23	17	18	0.12
0.0040–0.0059	7	100	2.49	7	57	0.54	7	29	0.29
0.0060–0.0079	5	100	1.00	5	80	0.84	5	40	0.08
0.0080–0.0099	4	75	1.10	4	25	0.20	4	0	0.00
0.0100–0.0149	3	100	0.33	3	0	0.00	3	0	0.00
0.0150–0.0199	2	50	1.50	2	0	0.00	2	0	0.00
0.0200–0.0249	3	67	4.27	3	33	0.13	3	0	0.00
0.0250–0.0299	1	100	3.00	1	0	0.00	1	0	0.00
0.0300–0.0399	1	100	0.80	1	0	0.00	1	0	0.00
0.0400–0.0499	1	100	0.20	1	0	0.00	1	0	0.00
0.0500–0.0999	1	100	1.60	1	100	0.20	1	0	0.00
0.1000–0.1499	1	100	5.20	1	0	0.00	1	0	0.00
0.1500–0.1999									
0.2000–0.2999	2	100	7.00	2	100	0.50	2	50	0.10

Nitrite nitrogen in part per million.	*Anopheles vagus.*			*Anopheles fuliginosus.*			Unidentified.			All species.		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*			*P. ct.*	
0.0000–0.0019	20	5	0.03	20	5	0.01	20	45	0.76	20	75	3.80
0.0020–0.0039	17	12	0.04	17	0	0.00	17	65	0.71	17	88	3.33
0.0040–0.0059	7	29	0.06	7	0	0.00	7	86	1.06	7	100	4.44
0.0060–0.0079	5	0	0.00	5	0	0.00	5	80	0.96	5	100	2.88
0.0080–0.0099	4	0	0.00	4	0	0.00	4	25	1.50	4	75	2.80
0.0100–0.0149	3	0	0.00	3	0	0.00	3	33	1.87	3	100	2.20
0.0150–0.0199	2	0	0.00	2	0	0.00	2	50	0.50	2	50	2.00
0.0200–0.0249	3	33	0.07	3	0	0.00	3	100	1.10	3	100	5.57
0.0250–0.0299	1	0	0.00	1	0	0.00	1	100	1.00	1	100	4.00
0.0300–0.0399	1	0	0.00	1	0	0.00	1	100	0.40	1	100	1.20
0.0400–0.0499	1	100	1.60	1	0	0.00	1	100	1.00	1	100	2.80
0.0500–0.0999	1	0	0.00	1	0	0.00	1	100	0.80	1	100	2.60
0.1000–0.1499	1	100	0.20	1	0	0.00	1	100	5.00	1	100	10.40
0.1500–0.1999												
0.2000–0.2999	2	0	0.00	2	0	0.00	2	100	7.10	2	100	14.70

TABLE 4.—*Occurrence and intensity of anopheline breeding in different concentrations of nitrate nitrogen.*

Nitrate nitrogen in part per million.	*Anopheles minimus.*			*Anopheles barbirostris.*			*Anopheles aconitus.*		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*	
0.000–0.009	3	67	1.40	3	100	2.60	3	0	0.00
0.010–0.019	12	100	2.17	12	83	2.03	12	42	0.32
0.020–0.029	11	91	1.35	11	82	1.35	11	45	0.15
0.030–0.039	11	36	0.33	11	36	0.45	11	0	0.00
0.040–0.049	11	91	1.46	11	27	0.45	11	0	0.00
0.050–0.059	2	50	1.40	2	50	0.20	2	0	0.00
0.060–0.069	3	100	6.60	3	67	0.53	3	0	0.00
0.070–0.079	3	100	3.80	3	33	0.13	3	33	0.07
0.080–0.089	2	100	0.20	2	50	0.10	2	0	0.00
0.090–0.099	1	100	3.00	1	0	0.00	1	0	0.00
0.100–0.124	4	50	1.80	4	50	0.40	4	0	0.00
0.125–0.149	1	0	0.00	1	0	0.00	1	0	0.00
0.150–0.199	1	100	1.60	1	100	0.20	1	0	0.00
0.200–0.299	1	100	1.00	1	100	0.80	1	0	0.00
0.300–0.399	2	100	2.80	2	0	0.00	2	0	0.00

Nitrate nitrogen in part per million.	*Anopheles vagus.*			*Anopheles fuliginosus.*			Unidentified.			All species.		
	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.	Observations.		Average larvæ per dip.
	Total.	Positive.		Total.	Positive.		Total.	Positive.		Total.	Positive.	
		P. ct.			*P. ct.*			*P. ct.*			*P. ct.*	
0.000–0.009	3	0	0.00	3	0	0.00	3	0	0.00	3	100	4.00
0.010–0.019	12	17	0.05	12	8	0.02	12	83	0.83	12	100	5.42
0.020–0.029	11	27	0.09	11	0	0.00	11	73	1.36	11	100	4.30
0.030–0.039	11	0	0.00	11	0	0.00	11	27	0.22	11	45	1.00
0.040–0.049	11	0	0.00	11	0	0.00	11	64	1.66	11	91	3.57
0.050–0.059	2	0	0.00	2	0	0.00	2	100	0.85	2	100	2.45
0.060–0.069	3	0	0.00	3	0	0.00	3	100	4.53	3	100	11.66
0.070–0.079	3	0	0.00	3	0	0.00	3	100	2.07	3	100	6.07
0.080–0.089	2	0	0.00	2	0	0.00	2	50	0.10	2	100	0.40
0.090–0.099	1	0	0.00	1	0	0.00	1	100	1.00	1	100	4.00
0.100–0.124	4	25	0.05	4	0	0.00	4	25	1.25	4	75	3.50
0.125–0.149	1	0	0.00	1	0	0.00	1	0	0.00	1	0	0.00
0.150–0.199	1	0	0.00	1	0	0.00	1	100	0.80	1	100	2.60
0.200–0.299	1	0	0.00	1	0	0.00	1	100	1.60	1	100	3.40
0.300–0.399	2	100	0.90	2	0	0.00	2	100	1.00	2	100	4.70

TABLE 5.—*Mean concentrations of ammonia nitrogen, albuminoid nitrogen, nitrite nitrogen, and nitrate nitrogen in Anopheles minimus breeding places, classified by month and year.*

Place, month, and year.	Observations.		Average larvæ per dip.	Temperature.	Salt concentrations in part per million.			
	Total.	Positive.			Ammonia nitrogen.	Albuminoid nitrogen.	Nitrite nitrogen.	Nitrate nitrogen.
BULACAN.		*P. ct.*		°*C.*				
April, 1931	3	100	1.40	32.2	0.225	0.576	--------	--------
May, 1931	12	67	0.45	32.2	0.114	0.362	--------	--------
June, 1931	13	54	0.42	30.0	0.071	0.235	--------	--------
July, 1931	11	36	0.25	30.9	0.078	0.214	--------	--------
August, 1931	2	0	0.00	26.0	0.020	0.108	--------	--------
September, 1931	6	0	0.00	27.4	0.071	0.154	0.0007	0.000
October, 1931	3	33	0.40	28.3	0.074	0.161	0.0007	0.000
November, 1931	3	100	3.93	27.7	0.047	0.173	0.0010	0.018
January, 1932	7	86	1.71	24.5	0.038	0.113	0.0024	0.007
February, 1932	4	75	0.60	26.4	0.025	0.103	0.0018	0.018
March, 1932	2	100	3.00	26.4	0.011	0.152	0.0035	0.020
April, 1932	32	100	1.68	27.1	0.166	0.166	0.0378	0.039
May, 1932	3	100	3.13	29.6	0.063	0.255	0.0020	0.030
June, 1932	5	80	0.34	28.3	0.093	0.146	0.0020	0.048
July, 1932	2	0	0.00	29.1	0.035	0.121	0.0020	0.030
August, 1932	4	0	0.00	28.4	0.071	0.097	0.0005	0.020
October, 1932	4	0	0.00	27.9	0.038	0.087	0.0012	0.023
December, 1932	2	0	0.00	24.8	0.030	0.078	0.0010	0.035
May, 1933	2	100	1.70	28.5	0.042	0.267	0.0020	0.035
March, 1934	4	50	1.10	30.1	0.245	0.501	0.0050	0.095
LAGUNA.								
January, 1932	1	0	0.00	26.0	0.092	0.184	0.0200	0.050
March, 1932	4	100	4.90	29.2	0.132	0.149	0.1400	0.195
May, 1932	2	100	0.90	28.2	0.060	0.303	0.0075	0.055
February, 1933	5	80	2.88	24.3	0.116	0.191	0.0100	0.078
March, 1933	6	80	4.20	26.4	0.465	0.214	0.0333	0.058
June, 1933	7	80	0.84	25.5	1.166	0.446	0.0140	0.043
January, 1934	2	100	--------	--------	0.100	0.432	0.0070	0.065
February, 1934	[a] 3	0	0.00	22.6	0.295	0.630	0.0023	0.060
April, 1934	3	67	0.40	20.5	0.063	0.142	0.0060	0.063
June, 1934	3	33	0.20	25.1	0.061	0.207	0.0013	0.033
July, 1934	2	100	1.30	27.5	0.148	0.230	0.0295	0.175
CAVITE.								
February, 1932	8	75	0.52	26.0	0.031	0.326	0.0059	0.034
April, 1932	1	100	0.60	31.4	0.034	0.230	0.0020	0.010
Do	[b] 2	100	1.55	33.2	1.076	0.883	0.0030	0.020

[a] Heavy rain and floods. [b] Stagnant pools.

case of two stagnant pools in Cavite Province where the concentration of ammonia and albuminoid nitrogen was much higher than that found in streams. However, more data are needed to verify this finding.

The records for August and September were negative for larvæ, due to heavy rains and floods which washed them away.

TABLE 6.—*Mean concentrations of ammonia nitrogen, albuminoid nitrogen, nitrite nitrogen, and nitrate nitrogen in Anopheles minimus breeding places, classified by month.*

Month.	Observations.		Average larvæ per dip.	Temperature.	Salt concentrations in part per million.			
	Total.	Positive.			Ammonia nitrogen.	Albuminoid nitrogen.	Nitrite nitrogen.	Nitrate nitrogen.
		P. ct.		°*C.*				
January	10	80	1.50	24.7	0.056	0.184	0.0051	0.023
February	20	65	1.05	25.0	0.089	0.299	0.0053	0.044
March	16	80	3.40	27.6	0.270	0.262	0.0491	0.097
April	41	98	1.25	27.4	0.203	0.222	0.0325	0.039
May	19	79	1.05	28.3	0.091	0.327	0.0036	0.039
June	28	62	0.46	28.3	0.348	0.269	0.0075	0.043
July	15	40	0.36	26.6	0.082	0.203	0.0157	0.102
August	6	0	0.00	27.2	0.054	0.101	0.0005	0.020
September	6	0	0.00	27.4	0.071	0.154	0.0007	0.000
October	7	14	0.17	28.1	0.053	0.119	0.0010	0.013
November	3	100	3.93	27.7	0.047	0.173	0.0010	0.013
December	2	0	0.00	24.8	0.030	0.078	0.0010	0.035

The same condition accounted for the percentage of negative observations made during the other months of the rainy season. The reasons for the negative results in the observations made during dry seasons are perhaps the variations in nitrogen and other physicochemical factors, the changes in the velocity of the stream at different stations, food supply, degree of shade or sun, and other factors.

Due to the small number of breeding places examined, this paper is presented as a preliminary report to give an idea of the composition of a typical *A. minimus* breeding place. In another paper more extensive data will be presented covering a larger number and variety of breeding places. It is hoped that further study may reveal specific differences in the breeding preference of *A. minimus* with a view to utilizing the findings in larval control.

SUMMARY AND CONCLUSION

A typical breeding place of *Anopheles minimus* var. *flavirostris* was examined for its nitrogen content, but for comparison a few examinations were also made of some other breeding places. The results of analyses of about 170 samples of water collected from these breeding places show that *A. minimus* breeds in bodies of water, notably streams, with low concentrations of ammonia nitrogen, albuminoid nitrogen, nitrite nitrogen, and

nitrate nitrogen, characteristic of unpolluted natural surface waters. The results on chlorides, iron, and other chemicophysical factors related to anopheles breeding will be reported in other papers.

ACKNOWLEDGMENT

I wish to acknowledge my obligation to Messrs. J. M. Ramos and E. Narcise for valuable assistance. To Dr. P. F. Russell, of the Rockefeller Foundation, and Dr. H. Lara, of the School of Hygiene and Public Health, I am indebted for important suggestions and criticisms.

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IS VITAMIN B_2 THE ACCELERATING FACTOR IN THE FERMENTATION OF SUGAR BY PROPIONIC ACID ORGANISMS? [1]

By V. G. LAVA, R. ROSS, and K. C. BLANCHARD

That the nitrogen source exerts considerable influence on sugar fermentation by propionic acid bacteria has been known for some time. Sherman(1) preferred milk whey to any other substance for his *Bacterium acidi propionici d.;* and Van Niel,(2) working with different strains of propionic acid bacteria, found that yeast extracts and yeast autolysates are better media than "Poulene," "Witte," "Bacto," and "Proteose" peptones; he showed that the differences in fermentation cannot be ascribed to differences in metabolism, buffer capacity, or nitrogen content, and suggested that the vitamin content of the yeast extract might play an important part.

Our experiments show that the factor in yeast extract responsible for increased fermentation is heat-stable in neutral or very acid conditions, is carried with the lead acetate precipitate at pH 7 to 7.5, and gives a progressive potency if purified according to the method of Euler(3) for vitamin B_2 separation.

EXPERIMENTAL

Throughout all our experiments yeast extracts were obtained according to the method of Van Niel with slight modifications: 250 g of Fleishman's compressed yeast was triturated with 1 liter of tap water, autoclaved with one egg white for thirty minutes at 122° C., filtered, and heated in an Arnold sterilizer for thirty minutes. In our case we added 3 cc concentrated hydrochloric acid (HCl) before autoclaving and, after filtering, further clarified the extract by adding another egg white before sterilizing in the Arnold. The extract obtained in this way was a clear yellow liquid.

The organism used was *Bacterium acidi propionici shermanii,* obtained from Doctor Sherman, of Cornell University. This

[1] Read before the Third Philippine Science Convention February 26, 1935. This work was undertaken in the Department of Biology, New York University.

organism was found to behave in the same way as an identical strain kindly sent us by the United States Department of Agriculture. Cultures were prepared of 25 cc of yeast extract containing 2 per cent of chemically pure glucose, inoculated with 1 cc and incubated at 30° C. for one week. Conditions of the highest sterility were always maintained. Unless otherwise stated, all flasks used in our fermentation experiments contained this 2 per cent glucose concentration.

As an index of the extent of fermentation the total acidity in each flask, containing 150 cc solution, was determined. Ducloux determinations were occasionally made to check the constancy of the $\frac{\text{propionic acid}}{\text{acetic acid}}$ ratio, and to determine indirectly whether bacterial contamination occurred. The pH of the medium at the time of inoculation was approximately 7 (range 6.8 to 7.6); the pH was determined with the antimony electrode, using the formula for the saturated calomel electrode at room temperature,

$$\text{pH} = \frac{0.005 \div \text{E. M. F.}}{0.058}$$

In order to determine which concentration of yeast extract was most suitable for our needs, fermentation experiments were carried out using various dilutions. Table 1 shows a typical relationship between titration value [in cc 0.1 *N* sodium hydroxide (NaOH)] after fifteen days' incubation and various dilutions of yeast extract. From these values a dilution of 1 : 3—that is, 50 cc yeast extract in 150 cc total volume—was selected for further experiments.

TABLE 1.—*Effect of concentration of yeast extract.*

Concentration of yeast extract.	pH (15 days).	0.1 *N* Sodium hydroxide (NaOH).	$\frac{\text{HP}}{\text{HAc}}$.
		cc.	
1/1	4.7	142.7	1:1.3
1/5	4.6	25.7	
1/25		4.8	
1/75		1.1	
1/375		0.7	

As it was fairly difficult to carry on experiments at the same salt concentration, the effect of salt concentration upon fermen-

tation was next determined. Table 2 shows the relation between salt concentration, calculated in terms of salt (NaCl) percentage, and titration value after fifteen days' incubation. In succeeding experiments corrections for salt concentration were made according to data in Table 2.

TABLE 2.—*Effect of salt concentration.*

[50 cc of yeast extract in 150 cc of medium and 2 per cent glucose.]

	Salt (NaCl).	pH (15 days).	Titration value 0.1 *N* sodium hydroxide (NaOH).	Acid produced.
	Per cent.		*cc.*	*Per cent.*
Experiment I	0.0	4.1	47.8	100.0
Do	0.13	4.1	47.8	100.0
Do	0.47	4.1	45.3	94.7
Do	0.93	4.2	43.3	90.4
Do	1.33	4.3	42.1	88.4
Experiment II	0.0	4.2	62.2	100.0
Do	2.0	4.2	46.2	74.3
Do	4.0	----------	0.0	0.0

For experiments in which complete fermentation is necessary, it is important that the time-titration value curve be first determined. Table 3 shows this relation. It is evident from

TABLE 3.—*Relation between titration value and time of fermentation.*

Time (days).	pH after fermentation.	Titration value 0.1 *N* sodium hydroxide (NaOH).
4	4.6	19.8
8	4.0	40.6
13	4.0	60.2
20	3.8	70.5
68	----------	70.5

these data that three weeks are sufficient for maximum fermentation. In all the succeeding experiments recorded, unless otherwise stated, three weeks is the incubation period.

EFFECT OF HEATING YEAST EXTRACTS AT DIFFERENT PH'S ON FERMENTATION

Portions consisting of 50 cc of yeast extract at pH 5.1 were treated with various amounts of hydrochloric acid (HCl) and sodium hydroxide (NaOH), made up to 100 cc and autoclaved

for thirty-five minutes, at 122° C. The pH in each flask was then adjusted to 7.1 and the flasks were heated in an Arnold sterilizer for twenty-five minutes, the pH again adjusted to 7.1, and the solutions made up to 150 cc after the addition of 3 g of glucose. The flasks were given a final sterilization in the Arnold, cooled overnight, and inoculated. Table 4 shows

TABLE 4.—*Effect of hydrolysis of yeast extract of different pH's on the titration value.*

0.2 *N* sodium hydroxide (NaOH) or hydrochloric acid (HCl) added before autoclaving.	pH after autoclaving.	0.2 *N* NaOH or HCl to make to pH 7.1.	pH (15 days).	Titration value cc 0.1 *N* NaOH.	Salt concentration.	Acidity corrected for salt concentration.	$\frac{HP}{HAc}$.
cc.		*cc.*			*Per cent.*	*Per cent.*	
20.0 (HCl)	2.2	22.5 (NaOH)	4.0	66.3	0.17	118	1:1.7
0.0 (NaOH)	5.1	3.5 (NaOH)	4.0	60.3	0.03	100	
1.0 (NaOH)	5.9	2.4 (NaOH)	4.0	61.5	0.03	109	
2.0 (NaOH)	6.4	1.4 (NaOH)	4.0	66.9	0.03	118	
3.0 (NaOH)	6.7	1.1 (NaOH)	4.0	62.4	0.03	110	
4.0 (NaOH)	7.2	0.1 (NaOH)	4.0	63.3	0.03	112	
5.0 (NaOH)	7.6	0.8 (HCl)	4.0	63.3	0.04	112	
6.0 (NaOH)	8.0	1.5 (HCl)	4.0	62.1	0.04	109	
8.5 (NaOH)	8.6	3.4 (HCl)	4.1	62.1	0.06	109	
45.0 (NaOH)	12.6	37.2 (HCl)	4.3	54.3	0.32	99	
35.3 (NaOH)	13.3	31.5 N(H_2SO_4)	7.0	0.0	1.36	0	

the effect of hydrolysis of yeast extract at different pH's on the titration value. It is evident from these figures that heating at a low pH maintains a high titration value, this value becoming lower near pH 4, increasing again to its maximum at pH 6.5, and gradually decreasing with increasing pH, till near pH 12.6 it decreases suddenly, and finally becomes zero at pH 13.3.

POTENCY OF FRACTIONS FROM LEAD ACETATE PRECIPITATION

Unfortunately data in the literature are conflicting regarding the effect of heat at different pH's on the stability of various water-soluble accessory food factors in yeast, and no very definite conclusions can be drawn from our results above as to what group our fermentation factor belongs in. However, the method that we used for the separation of different vitamin B fractions from yeast extract gives a qualitative idea as to where this factor is found most concentrated. It has been shown(4) that lead acetate at pH 7 precipitates most of the vitamin B_2 from the rest of the water-soluble factors in the filtrate. Treatment of this filtrate with Hopkins's mercuric sulphate ($HgSO_4$) re-

agent precipitates most of vitamins B_1 and B_4, leaving a filtrate that when treated with activated charcoal at pH 7 yields an adsorbate, which on further treatment with dilute hydrochloric acid (HCl) yields the X factor and on subsequent treatment of the charcoal with 50 per cent acid alcohol yields the Y factor.

In our experiments yeast extract was treated with neutral lead acetate, adjusted to pH 7 to 7.5 with sodium hydroxide (NaOH), and filtered. The filtrate was freed of lead by precipitating with sulphuric acid (H_2SO_4) and filtering, and the resulting filtrate was adjusted to 0.1 *N* acidity with saturated barium hydroxide [$Ba(OH)_2$]. This was filtered and yielded solution II. The precipitate of the lead acetate treatment was suspended in water and also treated with sulphuric acid (H_2SO_4) and filtered, and the acidity of the resulting filtrate was adjusted to 0.1 *N* with barium hydroxide [$Ba(OH)_2$] and filtered. The resulting filtrate is solution III. Throughout the processes as little heat as was compatible with the clearness of the solutions was administered.

As in preliminary experiments, we found that magnesium and phosphate ions increased fermentation; these were added in the form of potassium hydrogen phosphate (K_2HPO_4) (0.1 per cent) and magnesium sulphate ($MgSO_4.7H_2O$) (0.05 per cent). These concentrations were found by Pett and Wynne(5) to be the optimum concentrations for maximum fermentation of hexose phosphate and glycero-phosphate esters by dried *Bacterium acidi propionici jensenii* Van Niel. Table 5 shows the fermentation value for yeast extract, lead acetate filtrate, and lead acetate precipitate, separately and when mixed together, with and without Mg or PO_4 ions or with both. All these solutions were first adjusted to pH 7, sterilized, and readjusted to pH 7 before the addition of glucose and final sterilization.

The original total nitrogen content was determined in each solution by the Kjeldahl method to serve as a basis for determining the potency of each fraction. The data show that for the same amount of nitrogen the lead acetate precipitate (solution III) yields a more potent fraction than the lead acetate filtrate (solution II) and that the original yeast extract gave fermentation values between these two.

The difference in fermentation value cannot be due to differences in physiological activity of the organism nor to the general method of procedure, because duplicate fermentation

TABLE 5.—*Fermentation values with yeast extract (solution I), lead acetate [Pb(Ac)₂] precipitate (solution III), and lead acetate [Pb(Ac)₂] filtrate (solution II).*

Solution.	Ions added.	Titration value cc 0.1 *N* NaOH.	Comparative N content.	Titration value calculated to same N content.
cc extract in 150 cc total volume.				
50 cc solution I	None	(61.2) 59.5	0.120	(61.2) 59.5
Do	PO_4	70.0	0.120	70.0
Do	Mg	68.5	0.120	68.5
Do	Mg PO_4	(79.6) 82.5	0.120	(79.6) 82.5
50 cc solution II	None	32.5	0.078	49.5
Do	PO_4	55.5	0.078	85.0
Do	Mg	33.5	0.078	51.0
Do	Mg PO_4	50.0	0.078	76.5
50 cc solution III	None	(36.2) 36.5	0.046	(93.6) 94.5
Do	PO_4	53.0	0.046	138.0
Do	Mg	38.0	0.046	98.5
Do	Mg PO_4	58.0	0.046	150.0
50 cc solution I 50 cc solution II	None	103.0	0.198	62.5
Do	PO_4	115.5	0.198	70.0
Do	Mg	108.0	0.198	65.5
Do	Mg PO_4	124.0	0.198	75.0
50 cc solution I 50 cc solution III	do	129.0	0.166	93.0

values, in cases where they were taken, checked. Neither can these differences in fermentation value be due to possible precipitation of nitrogenous substances, since in some cases where heavy precipitates occurred after sterilization, fermentation values were very high; while in those cases where no precipitation occurred fermentation values were low. A more valid criticism would be that most of the gums having been included in the lead acetate precipitate might have been dissolved on treatment with sulphuric acid (H_2SO_4). The lead acetate precipitate fraction showed a reducing sugar content equivalent to 0.1 per cent, while the lead acetate filtrate gave 0.03 per cent glucose. Such small differences in glucose content over and above the original concentration of 2 per cent substrate cannot produce such considerable differences in fermentation value observed, especially in view of the fact that not all the original 2 per cent glucose is utilized even in those cases where maximum fermentation values are obtained. In Table 6, where fermentation value is determined from different original concentrations of sugar substrate, it can be seen that any small addition of sugar above 2 per cent has a negligible effect upon the fermentation value.

TABLE 6.—*Relation between titration value and original glucose concentration.*

[50 cc yeast extract adjusted to pH 7.1 before addition of glucose, H_2O, and final sterilization.]

Glucose added. Per cent.	Titration value. cc 0.1 *N* sodium hydroxide (Na OH).
0.0	1.5
2.0	60.0
5.0	69.0
8.0	73.5
15.0	76.5

Attention is called to the increasing effect of magnesium ion, of phosphate ion, and of a mixture of both on fermentation.

CONCENTRATION OF THE FERMENTATION FACTOR ACCORDING TO VITAMIN B_2 METHOD OF SEPARATION

Since the lead acetate separation shows that the potent substance is in its more concentrated form in the vitamin B_2 fraction, our next step was further to purify this fraction by the method of Euler(3) for vitamin B_2 separation.

The clear brownish solution III, obtained from the lead acetate precipitate, was treated with 15 per cent phosphotungstic acid dissolved in 5 per cent sulphuric acid (H_2SO_4) until precipitation was complete, and filtered. The amber-colored filtrate resulting from this is solution IV. In order to test the efficiency of removing the excess phosphotungstic acid, solution IV was divided into two portions. One portion was repeatedly shaken with iso-amyl alcohol until further extraction gave no test with zinc powder and concentrated hydrochloric acid (HCl) for the presence of phosphotungstic acid. The iso-amyl alcohol was then extracted with ether and the solution rid of ether by evaporation. The resulting solution, IV–b, was a bright clear yellow liquid. The other portion of solution IV was treated with a hot saturated solution of barium hydroxide [$Ba(OH)_2$] until definitely alkaline to litmus, and filtered. The resulting filtrate was a clear yellow solution (solution IV–a). Both solutions were then adjusted with sulphuric acid (H_2SO_4) to 0.1 *N* acidity, filtered, and portions of the filtrate used for experiments. As the higher potency of the fermentation factor was found in solution IV–b, as shown in Table 7, only this fraction was used in further purifications. Solution IV–b was then treated with 50 per cent silver nitrate ($AgNO_3$) to excess and filtered. The resulting filtrate was then carefully neutralized with sodium hydroxide (NaOH) and filtered. The resulting filtrate (solu-

tion VI) was colorless, but darkened on standing. The precipitate from this neutralization, on treatment with dilute hydrochloric acid (HCl) and filtering, yielded a filtrate (solution VII) that was clear, yellowish red, and highly fluorescent. Table 7 gives the fermentation value of the various fractions of purified yeast extract after adjusting the pH to 8 to 8.5. In all cases where yeast extract is used 50 cc were taken. This is true of all other fractions with the exception of solution VII, where 25 cc were used. The duration of fermentation was three

TABLE 7.—*Relation between titration value and N content of various vitamin B_2 purified fractions.*

Fraction used.	Titration value cc 0.1*N* NaOH.	Comparative N content.	Titration value corrected for salt concentration.	Corrected titration value calculated to same N content (0.139 per cent).
Solution I	(87.5)85.6	0.139	85.6	85.6
Solution I + Mg + PO_4	102.5	0.139	102.5	102.5
Solution II	46.5	0.073	48.4	92.0
Solution III	61.9	0.074	67.5	127.0
Phosphotungstic acid precipitate	19.0	0.086	19.2	31.0
Phosphotungstic acid precipitate + solution I.	116.0	0.225	117.4	72.5
Phosphotungstic acid precipitate + solution I + Mg + PO_4.	122.4	0.225	123.6	76.0
Solution IV-b	47.5	0.033	48.4	204.0
Solution IV-b + solution I	101.0	0.172	103.0	83.0
Solution IV-b + solution I + Mg + PO_4.	122.0	0.172	124.4	101.0
Solution IV-a	30.0	0.039	30.6	108.0
Solution IV-a + solution I	138.0	0.178	140.7	108.0
Solution IV-a + solution I + Mg + PO_4.	147.0	0.178	150.0	115.0
Acid $AgNO_3$ precipitate	9.0	0.011	9.2	116.0
Acid $AgNO_3$ precipitate + solution I	87.3	0.150	89.4	83.0
Solution VI	21.4	0.011	21.4	169.0
Solution VI + solution I	105.6	0.150	105.6	98.0
Solution VII	6.3	0.005	6.3	350.0
Solution VII + solution I	87.8	0.144	90.5	89.0
Solution VII + solution I + Mg + PO_4	112.0	0.144	115.3	114.0

weeks. Table 7 also verifies what has already been shown by Table 5, and further shows that those successive fractions proved to contain vitamin B_2 by rat tests are also the fractions which yield high fermentation values.

There is the possibility, however, that in the successive purifications of the yeast extract for vitamin B_2, certain amino acids favorable to the growth of the organisms are carried along with the vitamin, and due to their presence the titration values for

the purified fractions are increased. If this were true it would partly explain why the titration values (when calculated to the same nitrogen content) are almost the same as for those of yeast extract alone, without the purified extract.

On the other hand, the plotting of Van Niel's figures, showing the relation between titration values and nitrogen content for yeast autolysate and for peptone, and our figures for yeast extract (Table 10), show that while for peptone the titration value-nitrogen curve is linear for a wide range of nitrogen starting from zero, in the case of the yeast autolysate, the titration value increases suddenly with increasing nitrogen content and soon becomes a symptotic; our figures for yeast extract corresponding to a position between these two curves. These figures, then, would tend to show that the reason for no definitely increased titration values (calculated to the same N content), when our purified fraction was mixed with the original extract may be the fairly low concentration of the fermentation factor present in the purified extract as compared with the original yeast extract.

In order to settle this point, the amount of purified extract (solution VII) was varied, while the amount of original yeast extract was kept constant. Table 8 shows the effect of the concentration of solution VII on the titration value of the original

TABLE 8.—*Effect of varying concentrations of solution VII with some concentration of solution I on titration value.*

Solution I.	Solution VII.	Titration value (7 days) cc 0.1 *N* NaOH.	Titration value corrected for salt concentration.	Titration value difference per cc solution VII used.	Comparative N content.	$\frac{HP}{HAc}$.
cc.	*cc.*					
25	0	34.5	34.5	....	0.179	1:1.7
25	6	37.4	37.4	0.48	0.197	....
25	10	56.8	57.9	2.34	0.210	....
25	25	85.5	89.7	2.21	0.257	1:2.2
25	30	83.4	88.4	1.80	0.272	....
0	25	22.2	23.3	....	0.078	[a]

[a] Very little volatile acids.

yeast extract. As is shown in column 5 when only 6 cc of solution VII are used, the effect on the increase of titration value is 0.48 cc per 1 cc of solution VII. When 10 cc of solution VII are used, the titration value is increased to 2.34. When

25 cc are used, there is a slight decrease to 2.21, and when 30 cc are used there is a decrease to 1.80. If this change was simply due to the independent action of the organism on only the solution VII, the net increase per cubic centimeter of solution VII should be $\frac{23.3}{25}$ or about 1. When it is remembered that the concentration of the purified extract (solution VII) used in Table 7 is approximately only one-half of the concentration used in Table 8, which gave 0.48, it is clear why the effect of this extract in Table 7 was not so noticeable. Hence, it may be concluded that the effect of the purified extract is of enzymic nature and is shown very markedly only at certain high concentrations when mixed with the original yeast extract.

In this connection it may be pointed out that this purified extract (solution VII) seems to have the effect of inducing growth at a much earlier period. In the original yeast extract plus solution VII, growth subsides at the end of seven days, while in yeast extract alone the organisms remain alive even at the end of thirty days.

Another proof of the enzymic nature of solution VII may be obtained from the following experiment: An artificial medium was prepared containing in 300 cc the following:

	g.
D-glutamic acid	1.0
Arginine hydrochloride	0.5
Potassium hydrogen sulphate (K_2HPO_4)	1.0
Sodium chloride (NaCl)	1.8
Magnesium sulphate ($MgSO_4$)	1.09
Calcium chloride ($CaCl_2$)	1.03
Dextrose	6.0

The amino acids used were found to be present in fairly large quantities (in protein form) in cow's milk(6) and in yeast.(7) Fifty cc of this artificial medium were diluted to 150 cc in the usual way and used as a control. To another flask prepared in the same way 25 cc of solution VII were added and the solution diluted to 150 cc. After inoculation the flasks were incubated for thirty days. Table 9 shows the result of this experiment. It shows conclusively that while an artificial medium containing arginine and glutamic acid gave no growth or very little growth with propionic acid bacteria; when solution VII was added to the artificial media, propionic acid was formed and the ti-

TABLE 9.—*Incubation of artificial medium and solution VII.*

Media used.	Titration value (30 days).	Remarks.
Artificial (Al)	4.2	No odor of HP.
Al + solution VII	29.0	Distinct odor of HP, HAc.
Solution VII	6.3	Do.

TABLE 10.—*Relation between titrate V and per cent N of several media.*

Van Niel.				Our yeast extract.	
Peptone media.		Yeast autolysate.			
Per cent N.	Titration value.	Per cent N.	Titration value.	Per cent N.	Titration value.
0.9	11.2	0.5	28.7	0.14	9.5
0.32	8.0	0.16	27.2	0.028	1.7
0.08	3.3	0.09	24.4	0.006	0.3
0.016	0.7	0.02	16.8		

tration value was much greater than if solution VII alone were present as a medium.

CONCLUSION

While it has been shown that the potent substance responsible for increased fermentation of sugar by propionic acid bacteria is in the vitamin B_2 fraction, it cannot be proved at this stage of our work that vitamin B_2 itself is the potent substance. Ellinger and Koschara(8) have shown that water-soluble animal pigments (lyochromes), which they prepared from milk whey, contained vitamin B_2. Kuhn, György, and Wagner-Jauregg(9) have also demonstrated the presence of vitamin B_2 in their preparation of lactoflavins from milk whey, which they obtained by adsorption on fuller's earth in acid solution and elution of the adsorbate with a mixture of pyridin, methyl alcohol, and water; and Stern(10) has demonstrated that these flavins function as oxidation-reduction enzymes. Whether our fermentation factor is a flavin or vitamin B_2 or a mixture of these, and whether lactoflavin and vitamin B_2 are identical, remain to be proved.

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INDEX OF TEXTURE AND CLASSIFICATION OF PHILIPPINE SOILS

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INTRODUCTION

At present there are no accepted standard physical specifications for soils except the results of mechanical analysis. The physical properties of soils, as determined by mechanical analysis, have been used for years by the United States Bureau of Chemistry and Soils for the classification and mapping of soils of the United States.

As it is rather tedious to make a mechanical analysis, it would be very desirable to have some simpler method for acquiring the data necessary for soil classification.

Hardy has suggested a method whereby the moisture content of soils at the sticky point and also a fifth of the sand content can be represented by one value. This is called the index of texture and is expressed as follows:

$$\text{Index of texture} = \text{Moisture at sticky point} - \frac{\text{Per cent of sand}}{5},$$

$$\text{or} \qquad \text{I. T.} = \text{M. S. P} - \frac{\text{Per cent sand}}{5}.$$

A description of soils according to Hardy's texture index is given below.

Texture index.	Type of soil.
10 to 25	Sand.
25 to 40	Sandy loam.
40 to 50	Silt loam or loam.
50 to 55	Clay loam.
55 to 60	Heavy clay.

The texture index, which can be readily obtained, has been considered as a possible standard for the classification of soils. In order to test the accuracy of this suggested standard it would seem desirable to investigate a number of soils and obtain experimental data on the texture index and the mechanical analysis.

The investigation was undertaken to ascertain the accuracy of the texture index for classifying Philippine soils and also to determine what limitations it may have.

EXPERIMENTAL PROCEDURE

The materials used in this investigation consisted of thirty-eight samples of soils that were obtained from nine different excavations. Samples 1 to 10 came from Tagaytay Ridge, Cavite. The remaining samples were from Tuguegarao, Cagayan, a tobacco region. Both of these localities are in Luzon. A description of each soil sample is given in Table 1.

The mechanical analyses of these soils were made in accordance with the method of Olmstead, Alexander, and Middleton. For the determination of the texture index the procedure of Hardy was followed.

Data for the mechanical analyses are given in Table 2. In recording these results the sand separate was reported as total sand of the sample. As shown by the data the samples of soil selected for this work consisted of various textural types from coarse sandy loam to heavy clay and adobe clay. In the Tagaytay sandy loam type the surface soil is sandy loam, the subsoil is loam to clay loam, and the substratum is clay to adobe clay. Soils from Tuguegarao vary in textural grades from silty loam to silty clay.

In Table 3 are given the index of texture and the clay-sand ratio $\left\{\frac{\text{clay}}{\text{sand}}\right\}$ for the various soils examined.

The soil samples were separated into three groups in accordance with the index of texture. Group 1 (Table 4) consisted of soils that had a texture index below 36, the soils in group 2 (Table 5) had a texture index of 36 to 50, and those in group 3 (Table 6) a texture index above 50.

In comparing the data recorded in Tables 4, 5, and 6 with the descriptions of the soils given in Table 1 and the mechanical analyses in Table 2 we find the following:

Soil group.	Texture index.	Type of soil.
1	Below 36	Mostly sand, sandy, or silty loam.
2	36 to 50	Uncertain.
3	Above 50	Clay loam or heavy clay.

The soils in group 1 (Table 4) are all mostly sand, sandy, or silty loam. Those in group 3 (Table 6) are all clay loam or heavy clay.

Classification according to the texture index is uncertain for those soils included in group 2 (Table 5). For instance, sample 5 (Table 5) had an index of 44.8 and sample 16 an index of 44.9. The index was about the same for these two samples, but the mechanical analyses (Table 2) gave quite different results, as shown below:

	Sample 5.	Sample 16.
	Per cent.	Per cent.
Sand	48.9	20.8
Silt	22.3	35.2
Clay	28.8	44.0

Sample 5 was a rather sandy soil, whereas sample 16 contained much less sand and considerably more clay than sample 5. This and similar examples illustrate the general trend of the results obtained for the soils in group 2 (Table 5).

Our data show that the texture index may, in general, be used for classifying Philippine soils that have a texture index below 36 or above 50. Between these limits the texture index is not a reliable criterion for classifying soils.

Classification of Philippine soils into different types in accordance with the texture index is quite different from the classification suggested by Hardy. Apparently the index of texture has only a limited application for Philippine soils.

SUMMARY

Thirty-eight samples of soils obtained from nine different localities were investigated.

For each of these soil samples a mechanical analysis was made, the index of texture determined, and the clay-sand ratio calculated.

The soil samples were separated into three groups according to the index of texture. Group 1 contained soils that had a texture index below 36, the soils in group 2 had an index of 36 to 50, and those in group 3 an index above 50.

From the results we have obtained it would appear that the soils in group 1 (texture index below 36) may be classified as mostly sand, sandy, or silty loam.

The soils in group 3 (index above 50) may be classified as clay loam or heavy clay.

Group 2 (index 36 to 50) contained soils that could not be classified exactly according to the texture index.

Apparently the index of texture has only a limited application for the classification of Philippine soils.

Classification of Philippine soils into different types in accordance with the texture index is quite different from the classification suggested by Hardy.

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TABLE 1.—*Descriptions of the soil samples.*

Sample No.	Depth of sample.	Morphological description.
	cm.	
1	0–24	Very dark brown to nearly black, granular, and friable sandy loam.
2	24–60	Very dark brown to nearly black, granular, and friable loam to clay loam.
3	60–100	Light reddish brown clay loam to clay; sticky when moist but friable when dry.
4	100–130	Yellowish brown adobe clay; adobe rock parent material of the subsoil.
5	0–15	Very dark brown to nearly black, loose, and granular sandy loam.
6	15–60	Light reddish brown clay loam; sticky when moist but friable when dry.
7	60–110	Yellowish brown adobe clay.
8	0–10	Dark brown to nearly black, coarse, granular, and loose and friable sandy loam.
9	10–60	Dark brown loam to clay loam; granular and slightly friable.
10	60–130	Light reddish brown clay loam to clay; heavy and sticky.
11	0–11	Grayish brown, loose and structureless silt loam.
12	11–15	Loose and granular silt loam; mottled brown, yellow, and gray.
13	15–20	Dark grayish brown, hard and brittle, heavy silt loam, mottled yellow and gray.
14	20–33	Dark grayish brown, brittle silty loam.
15	33–50	Hard and brittle silty clay loam; mottled yellow, brown, and purplish gray.
16	50–89	Mottled purplish brown and yellowish brown, brittle silt loam.
17	89–102	Mottled purplish brown and yellowish brown, friable silt loam.
18	102–120	Mottled purplish gray and yellowish brown, silty loam.
19	13–26	Dark brown, brittle silty clay with yellowish brown specks.
20	26–58	Dark brown, stiff clay or silty clay with yellowish brown streaks.
21	58–63	Dark brownish gray, friable and granular silty clay loam.
22	63–100	Mottled gray and yellowish brown, silty clay; partially decomposed.
23	0–30	Dark brown, friable silt loam.
24	30–43	Chocolate-brown with purplish tinge, friable silt loam, heavier than No. 23.
25	43–60	Light chocolate-brown with yellowish brown mottlings; silt loam to silty clay loam.
26	60–80	Light brown with yellowish brown mottlings, slightly friable, silty clay loam.
27	80–100	Light chocolate-brown with yellowish brown mottlings; silt loam to silty clay loam but light in texture.
28	10–30	Dark brown to light brown, massive and compact clay loam.
29	30–50	Light brown, granular, and slight friable clay with yellowish brown concretions.
30	50–100	Grayish brown, nearly compact silt loam.
31	0–24	Do.
32	24–49	Light yellowish brown, nearly compact silt loam.
33	49–70	Light yellowish brown, compact silt loam.
34	70–105	Yellowish brown, compact and fine, granular silt loam.
35	0–18	Gray, loose and granular, silty loam.
36	18–28	Grayish brown, loose and granular loam.
37	28–48	Yellowish brown, granular and nearly compact loam.
38	48–90	Yellowish brown granular loam, grading into fine sandy loam.

TABLE 2.—*The mechanical analyses of soil samples.*

Sample No.	Sand, 2 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0.0 mm.	Sample No.	Sand, 2 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, .005 to 0.0 mm.
	Per cent.	*Per cent.*	*Per cent.*		*Per cent.*	*Per cent.*	*Per cent.*
1	49.8	24.3	26.0	20	26.2	21.9	51.9
2	25.0	28.5	46.5	21	26.5	22.3	51.2
3	25.5	21.8	52.7	22	41.1	15.6	43.3
4	35.6	16.7	47.7	23	13.8	50.2	36.8
5	48.9	22.3	28.8	24	11.7	48.6	39.7
6	28.3	27.2	44.5	25	11.1	35.0	53.9
7	31.7	29.9	38.4	26	14.0	43.3	42.7
8	41.9	26.6	31.5	27	26.9	42.7	30.4
9	11.9	35.5	52.6	28	31.0	29.3	39.6
10	15.0	33.5	51.5	29	21.2	37.1	41.7
11	17.8	46.4	35.8	30	17.6	31.7	50.7
12	17.6	42.2	40.2	31	46.4	30.8	22.8
13	14.1	44.7	41.2	32	43.1	33.0	23.9
14	18.6	36.6	42.8	33	53.3	26.8	19.9
15	14.7	41.1	44.3	34	43.2	34.7	22.1
16	20.8	35.2	44.0	35	49.0	32.4	18.6
17	34.5	24.9	30.6	36	42.3	28.3	29.4
18	40.7	32.9	26.4	37	43.7	22.5	33.8
19	27.6	21.6	50.8	38	48.0	21.1	31.2

TABLE 3.—*Clay-sand ratio* $\left\{\frac{clay}{sand}\right\}$ *and index of texture.*

Sample No.	Ratio, $\frac{\text{clay}}{\text{sand}}$.	Index of texture.	Sample No.	Ratio, $\frac{\text{clay}}{\text{sand}}$.	Index of texture.
1	0.52	37.0	20	1.98	50.6
2	1.86	61.0	21	1.93	50.0
3	2.06	71.7	22	1.05	42.2
4	1.33	68.8	23	2.66	43.2
5	0.58	44.8	24	3.39	47.1
6	1.57	63.1	25	4.85	49.2
7	1.21	62.2	26	3.05	46.6
8	0.74	44.1	27	1.13	41.4
9	4.42	75.7	28	1.27	36.4
10	3.43	74.8	29	1.96	40.0
11	2.01	41.6	30	2.88	62.6
12	2.28	41.8	31	0.49	31.7
13	2.92	45.7	32	0.55	33.2
14	2.30	45.2	33	0.37	30.3
15	3.01	46.0	34	0.51	32.7
16	2.12	44.9	35	0.37	30.4
17	0.88	35.2	36	0.69	32.8
18	0.64	35.7	37	0.77	32.3
19	1.84	49.8	38	0.65	30.4

TABLE 4.—*Soils having a texture index below 36.*[a]

[Group 1.]

Sample No.	Ratio, clay/sand.	Index of texture.	Sample No.	Ratio, clay/sand.	Index of texture.
17	0.88	35.2	34	0.51	32.7
18	0.64	35.7	35	0.37	30.4
31	0.49	31.7	36	0.69	32.8
32	0.55	33.2	37	0.77	32.3
33	0.37	30.3			

[a] These soils may be classified according to the texture index as mostly sand, sandy, or silty loam.

TABLE 5.—*Soils having a texture index of 36 to 50.*[a]

[Group 2.]

Sample No.	Ratio, clay/sand.	Index of texture.	Sample No.	Ratio, clay/sand.	Index of texture.
1	0.52	37.0	21	1.93	50.0
5	0.58	44.8	22	1.05	42.2
8	0.74	44.1	23	2.66	43.2
11	2.01	41.6	24	3.39	47.1
12	2.28	41.8	25	4.85	49.2
13	2.92	45.7	26	3.05	46.6
14	2.30	45.2	27	1.13	41.4
15	3.01	46.0	28	1.27	36.4
16	2.12	44.9	29	1.96	40.0
19	1.84	49.8			

[a] Classification of these soils according to the texture index is uncertain.

TABLE 6.—*Soils having a texture index above 50.*[a]

[Group 3.]

Sample No.	Ratio, clay/sand.	Index of texture.	Sample No.	Ratio, clay/sand.	Index of texture.
2	1.86	61.0	9	4.42	75.7
3	2.06	71.7	10	3.43	74.8
4	1.33	68.8	20	1.98	50.6
6	1.57	63.1	30	2.88	62.6
7	1.21	62.2			

[a] These soils may be classified according to the texture index as clay loam or heavy clay.

OBSERVATIONS ON THE LIFE CYCLE OF GNATHOSTOMA SPINIGERUM [1]

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THREE PLATES

INTRODUCTION

Human gnathostomiasis is unknown in the Philippines, although *Gnathostoma spinigerum* Owen has been observed frequently in the stomach of cats in this country (Tubangui, 1925). In Siam gnathostome infestation is not uncommon in man, as indicated by the five reported cases from that country (Levinsen, 1889; Leiper, 1909; Robert, 1922) and the seven new cases collected by Prommas and Daengsvang (1933) during a period of two years. This infestation has also been reported in man once from the Federated Malay States (Samy, 1918), thrice from China (Tamura, 1921; Morishita and Faust, 1925), once from Japan (Morishita, 1924) and twice from India (Maplestone, 1929; Datta and Maplestone, 1930). Curiously enough all the worms collected from human cases were immature and found in peripheral lesions.

The knowledge of the life cycle of *Gnathostoma spinigerum* is fragmentary. Chandler (1925) found larval gnathostomes encysted in the mesentery of the rock python (*Python reticulatus*), the king cobra (*Naja bungarus*), and the common cobra (*Naja tripudians*), which when fed to cats formed burrows in the liver or became embedded in the parietal peritoneal wall or renal capsules instead of developing into adult worms inside nodules in the stomach wall, but he was at a loss to establish the connection between these larvæ and the adult gnathostome. The first important contribution to the knowledge of the life cycle of this worm was furnished by Heydon (1929), who observed that the eggs of *Gnathostoma spinigerum* obtained from

[1] The work was made possible through a research grant from the Board of Regents, University of the Philippines. Received for publication January 15, 1936.

an infected cat, when kept in shallow water at room temperature developed inside fully motile larvæ in five days and, if kept in water up to twenty-three days, a certain proportion of them hatched out spontaneously embryos inclosed in large, loosely fitted, delicate sheaths. Evidently influenced by Heydon's work, Prommas and Daengsvang (1933) attempted to infect white rats by feeding them with fully developed embryonated eggs and newly hatched larvæ of *Gnathostoma spinigerum* with negative results. Skin penetration by newly hatched larvæ in experiments conducted on rats and mice did not occur. Attempts to infect *Ctenocephalus canis* and *C. felis* by allowing them to feed on *Gnathostoma* eggs containing fully developed motile embryos also gave negative results. These writers were, however, successful in infecting an apparently unidentified species of *Cyclops* with newly hatched motile larvæ of *Gnathostoma spinigerum.* The larvæ very soon pierced the gastric wall into the body cavity of the cyclopes after ingestion. In the body cavity of the crustacean, *G. spinigerum* larvæ underwent metamorphosis. Their size gradually increased and was 372.5 by 61.6 μ at 14 days of age. Fully developed larvæ, which showed structures similar to those found in the adult worm, were observed in the body cavity of the cyclopes in about seven days, although some may require a longer period. These results led the authors to conclude that "suitable and unsuitable hosts possibly get Gnathostome infestation by drinking water containing infected cyclops." Recently, however, we found gnathostome larvæ, presumably those of *G. spinigerum,* encysted in the muscles of three species of fresh-water fishes in Laguna de Bay, a lake about 25 kilometers south of Manila. As this finding promises to establish a natural and logical connection between the adult gnathostome in mammals and the experimental gnathostome larvæ in the *Cyclops* of Prommas and Daengsvang, we have decided to follow this clue. In this paper we are reporting the results of our preliminary investigation.

MATERIALS AND METHODS

Late in 1935, while searching for metacercariæ of heterophyid flukes in the muscle of some of our fresh-water fishes in connection with another work, we accidentally encountered in the flesh of *Glossogobius giurus* (Hamilton-Buchanan) (locally known as "bia") nine encysted gnathostome larvæ, which, judg-

ing from their size and structure, are presumably those of *G. spinigerum*. Subsequently the same larvæ were found in the muscle of *Ophicephalus striatus* Bloch ("dalag") and *Therapon argenteus* (Cuvier and Valenciennes) ("ayuñgin"). All of the eleven *Glossogobius giurus* examined were found to harbor the larvæ, an incidence of 100 per cent; of eight *Ophicephalus striatus* two were infected, an incidence of 25 per cent; and of twenty-three *Therapon argenteus* examined three yielded larvæ, an incidence of 12.6 per cent. All these fishes are abundant in Laguna de Bay. Cats and dogs imported from Biñan, a town on the shore of this lake, were autopsied to determine the presence of adult gnathostomes in these animals. In two of six cats autopsied, adult gnathostomes were found in typical nodules in the stomach wall without visible communication with the gastric cavity. Immature worms were also found buried in the livers of these two cats. The adult worms obtained from the stomach nodules answer faithfully the description of *Gnathostoma spinigerum,* even to the detail of the body spine as given by Faust (1929), except that our specimens possess nine transverse rows of cephalic hooklets instead of eight. However, according to Baylis and Lane (1920) the number of transverse rows of cephalic hooklets varies from eight to eleven in *Gnathostoma spinigerum*. Two of the seven dogs from the same town showed immature gnathostomes in the liver, identical with those found in the same organ of cats. A large number of cyclopes and small crayfishes were examined right in the town during a survey trip, but in no instance was a *Gnathostoma* larva encountered.

EXPERIMENTS

November 13, 1935.—Seven gnathostome larvæ obtained from the flesh of *Glossogobius giurus* were fed to a white rat which was killed nine days later (November 22). No worms were found in the stomach.

November 20, 1935.—Six gnathostome larvæ from *G. giurus* were fed to a white rat. The animal died November 28. The stomach was negative. Thinking that the larvæ might have gone to some peripheral focus, we included the liver in the examination, and two larvæ were found buried in this organ, causing a lesion similar to that described by Chandler in the livers of his experimental cats.

November 27, 1935.—Seven gnathostome larvæ from *G. giurus* were fed to a white rat, which was killed on December 7. One larva was found in what appeared to be a minute nodule in the stomach wall, and two were recovered from the liver.

December 16, 1935.—Nine gnathostome larvæ from *G. giurus* and seven from *Ophiocephalus striatus* were fed to a white rat, which was killed January 10, 1936. As the animal was killed twenty-four days after the infestation the possibility of finding larvæ in the muscles was considered. Six larvæ were found in the obliquus abdominis externus and posterior superficial pectoral muscles and one in the liver. There was no difference noted in either size or structure between the larvæ found in the muscle and the one in the liver.

December 31, 1935.—A survey trip to Biñan was made. A number of fishes of the species *G. giurus, O. striatus,* and *T. argenteus* caught in the nearby Laguna de Bay were examined and larvæ were found in each species. Two snakes examined were negative for gnathostome. Many cyclopes of different species were examined for gnathostome larvæ, but all were negative. Small shrimps and crayfishes were also examined, but were likewise negative.

Experimental infestation of cats has not been made because of the difficulty of finding animals that are absolutely free from infestation. Absence of eggs in the stool does not prove that a cat is free of this worm, because in some cases the nodule which contains the adult worms is devoid of an opening that would permit the free passage of eggs to the stomach lumen. We are expecting to conduct feeding experiments on cats in the near future, as we have several expectant cats which we hope will provide us with sufficient kittens free from infestation.

Experimental infestation of cyclopes has likewise not been made because we lacked infected cats that could supply us with eggs, but we hope soon to be able to perform this experiment to see if we can infect *Ophiocephalus striatus,* which can be cultivated in aquaria, with gnathostome larvæ by feeding it with infested cyclopes.

DISCUSSION

The success of Prommas and Daengsvang in infesting *Cyclops* with larvæ of *Gnathostoma spinigerum* and our discovery of *Gnathostoma* larvæ (presumably of *G. spinigerum* also) in the muscles of fresh-water fishes in a lake in the region around

which adult *G. spinigerum* appears to be a common natural infestation in the stomach of cats, promise an early solution of the life cycle of this worm. Although the possibility of direct infestation of suitable and unsuitable hosts by drinking water containing infected cyclopes as suggested by Prommas and Daengsvang cannot be entirely ruled out, infestation of these hosts by eating raw infested fish would appear to be the more natural and logical process, since the cat and the dog as well as human beings are by nature piscivorous. It would be interesting to know whether these authors have already succeeded in establishing infestations in these hosts by feeding them with infected cyclopes.

The size given by Prommas and Daengsvang for "mature" larvæ in their experimentally infected cyclopes is 0.3725 mm by 0.0616 mm. They remarked that no further change in structure was noted once this size was reached (which is on or about the seventh day) even when kept in the crustacean up to one month. Our gnathostome larvæ from fish muscles are considerably larger, having an average measurement of 4.5 mm by 0.312 mm, or approximately twelve times larger than the maximum development attained in the crustacean host (see Table 1). This would indicate that the larvæ undergo further development in the fish if we assume for the moment that the latter serves as the second intermediate host of *Gnathostoma spinigerum.* It would be easier and more logical to explain infestation of cats, dogs, and man by the ingestion of raw infected fish than by drinking water containing infected cyclopes, since, as has been pointed out, these hosts are by nature fish-eating; furthermore, it would be difficult to explain the light infestations usually observed in these mammalian hosts were they contracted by drinking water containing infected cyclopes. We observed that infestation in the fish is relatively light, the larval yield never exceeding nine in each fish in a total of forty-two dissections.

In India Chandler, as mentioned elsewhere in this paper, found gnathostome larvæ in the mesentery of snakes, which upon being fed to cats form burrows in the liver, or become embedded in the parietal peritoneal wall or the renal capsules instead of developing into adult worms inside nodules in the stomach. The larvæ in the cat, except for their considerably larger size, resemble the ones in the reptilian host in every other respect. Significantly the larvæ obtained by Chandler from the snakes approximate our larval gnathostome from the fish in size and

structure; furthermore, if these larvæ from the fish were fed to white rats much larger larvæ, which resemble in size and structure those recovered by Chandler from the liver of his experimental cats, could be found in the liver of white rats in from eight to ten days. By keeping the larvæ much longer (24 days) in white rats, larvæ could be obtained from the skeletal muscles of this animal. Morishita and Faust (1925) described larval gnathostome from the peripheral lesions in the human host which, like the ones recovered by Chandler from his experimental cats fed with larvæ of reptilian origin, differ from the adult *Gnathostoma spinigerum* in having only four instead of eight rows of transverse cephalic hooklets. Chandler suggests that the worms only attain full development after a final moult. Since the gnathostomes described by Leiper (1909) and Tamura (1921) from peripheral lesions in man were provided with a full compliment of hooklets, and in both size and structure were practically mature, one may be tempted to assume in a speculative manner that the worms of Chandler in the liver and peritoneum of his experimental cats and of Morishita and Faust in somatic foci in man could have developed, if they had been given sufficient time, to the semimature worms of Leiper and Tamura. We hope to verify this point by keeping the larvæ long enough in the body of our experimental animals. That gnathostomes need not necessarily be confined in the stomach of the cat is shown not only by the finding of Chandler but also by our own discovery of immature larvæ burrowing in the liver of naturally infested cats.

At this stage of our knowledge it is risky to speculate on the rôle played by snakes in the life cycle of the gnathostome. Do they get their infestation by eating infected fish, or do they infect themselves by drinking water containing infected cyclopes? Both are possible. However, the fact that the larvæ from the reptilian hosts approximate both in size and structure the larvæ from the flesh of fish would imply that snakes act in the same capacity as the latter animal. Having dissected so many snakes and obtained so many larvæ it is improbable that Chandler could have missed larger forms if these reptilian hosts allow further development of the worms in their bodies. Furthermore, snakes do not seem to include fish in their diet. On the other hand, it is still possible to find larger and structurally more developed larvæ in the snakes like those found by Morishita and Faust and by Leiper and Tamura in man. If this is found to be true,

the snakes would naturally assume the rôle of the so-called unsuitable hosts of *Gnathostoma* and not secondary intermediate hosts. An extensive dissection of reptilian hosts is necessary to clear this point. The possibility that snakes get infected with gnathostome larvæ by eating rats (and cats in the case of the python) is hardly tenable since the larvæ obtained by Chandler in these reptiles were smaller than those we found in the liver and muscles of experimentally infested rats and in the liver of a naturally infested cat. Besides, the larvæ in the snakes when fed to cats have been found by Chandler to undergo further development in the liver of the latter.

As regards the piscine hosts it appears more logical and natural that they get their infection by eating infected crustaceans, which are the natural food of fish. However, extensive search for infected cyclopes in Laguna de Bay, where infected fish abound, proved unsuccessful. Could this mean that cyclopes can be infected only when no other crustacean is present, as is the case under laboratory conditions; or, to put it in another way, is it possible that there are other crustaceans preferred by the hatched larvæ of *Gnathostoma* for their first development? Would they encyst in *Daphnea,* small shrimps, and other fresh-water crustaceans? We have made a preliminary survey of these possibilities with negative results. It would be interesting to put these possibilities to further tests.

SUMMARY

1. Cats obtained from Biñan, a town on the shore of Laguna de Bay, were found to harbor adult *Gnathostoma spinigerum* Owen contained in the stomach nodules. However, immature larvæ have been found to wander to somatic foci (liver) of a naturally infested cat.

2. Dogs from the same region are also naturally infested with this worm, but so far only immature worms in burrows in the liver have been found.

3. Encysted gnathostome larvæ of uniform size and structure (presumably of *G. spinigerum*) have been discovered in the muscles of three species of fresh-water fishes caught in Laguna de Bay; namely, *Glossogobius giurus* (Hamilton-Buchanan) (locally known as "bia"), *Ophiocephalus striatus* Bloch (locally known as "dalag"), and *Therapon argenteus* (Cuvier and Valenciennes) (locally known as "ayuñgin"). When these en-

cysted larvæ were fed to white rats, larvæ which seem to have undergone development both in size and structure developed in the liver and skeletal muscles of this animal.

4. Suitable and unsuitable hosts possibly get gnathostome infestation, not by drinking water containing infected cyclopes, but by eating raw fresh-water fish infested with larvæ which they possibly get by ingesting infected cyclopes.

5. Further studies of this subject are in progress.

ACKNOWLEDGMENT

We acknowledge our indebtedness to Dr. Walfrido de Leon, of the Department of Sanitary Bacteriology and Immunology, for the microphotography.

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TABLE 1.—*Relative measurements of gnathostome larvæ.*

	From *Cyclops* of Prommas and Daengsvang. (Experimental.)	Natural infestation.				Artificial infestation.		
		From snakes of Chandler.	From flesh of our fish.	From liver of our puppy.	From liver of our cat.	From liver of Chandler's cat.	From liver of our white rat.	From muscle of our white rat.
Length ..... mm	0.372	3-3.86	4.5	6.0	5.0	([b])	5.6	5.2
Width ..... mm	0.0616	0.4-0.45	0.312	0.412	0.36	([c])	0.45	0.37
Globular cephalic swelling ..... mm	([a])	0.21 by 0.1	0.2 by 0.12	0.24 by 0.13	0.23 by 0.11	([a])	0.22 by 0.13	0.19 by 0.75
Œsophagus:								
Length ..... mm	([a])	([a])	1.437	1.62	1.55	([d])	1.69	1.4
Width at bulbous portion ..... mm	([a])	([a])	1.187	1.287	0.25	([a])	0.27	0.18
Intestine length ..... mm	([a])	([a])	2.5	2.58	2.75	([a])	3.5	2.91
Hooklets:								
Rows	4	4	4	4	4	4	4	4
Size ..... μ	([a])	([a])	17 by 7	12.5 by 8	13.5 by 8	([a])	3 by 8	12.5 by 7

[a] Not given.
[b] 4 to 5.6 mm at two days; 6.2 to 6.85 mm at eleven days.
[c] 0.4 to 0.5 mm after two days; 0.52 to 0.57 mm after eleven days.
[d] 27 to 33 per cent of body length.

ILLUSTRATIONS

PLATE 1

FIG. 1. Anterior end of *Gnathostoma* larva from the flesh of *Ophicephalus striatus* Bloch ("dalag"); low power.

2. The cephalic bulbar enlargement of the same larva, showing the detail of the four transverse rows of cephalic hooklets; high power.

PLATE 2

FIG. 1. A section of the muscle of *Glossogobius giurus* (Hamilton-Buchanan) ("bia"), showing an encysted gnathostome larva; low power.

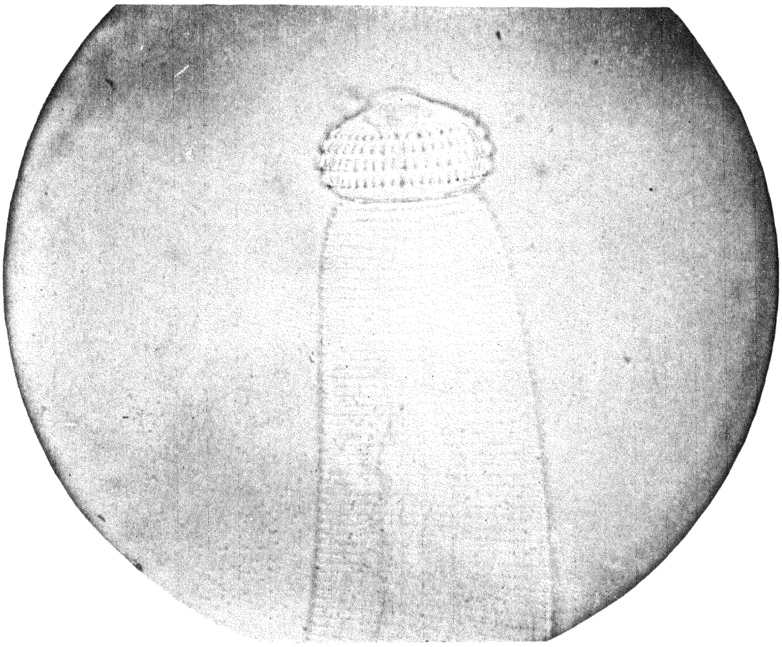
2. A section of the posterior superficial pectoral muscle of an experimental white rat, showing a gnathostome larva sagittally sectioned; low power. A part of the worm is not shown. Note that it has evidently grown both in size and structure.

PLATE 3

FIG. 1. *Glossogobius giurus* (Hamilton-Buchanan) ("bia").

2. *Ophicephalus striatus* Bloch ("dalag").

3. *Therapon argenteus* (Cuvier and Valenciennes) ("ayuñgin").



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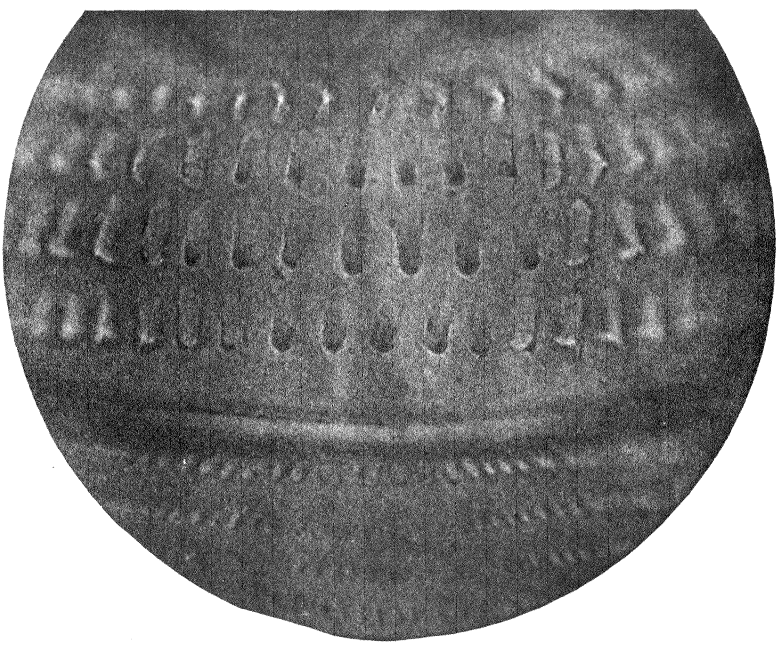

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PLATE 1.

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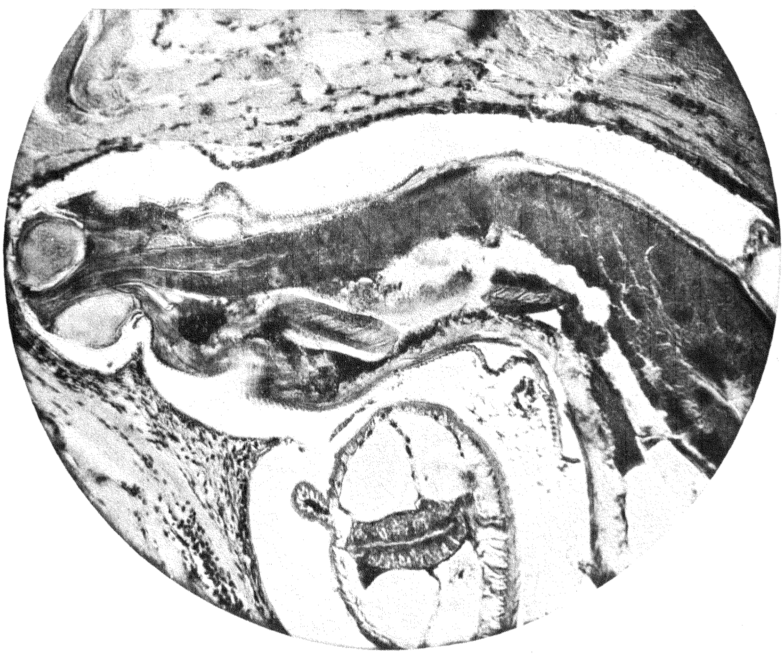

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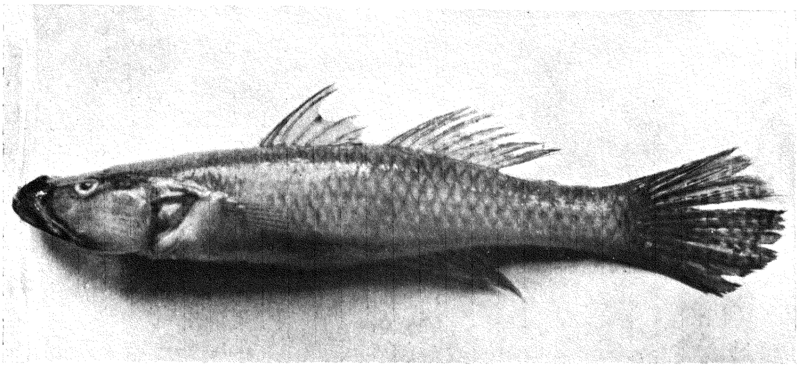
PLATE 2.



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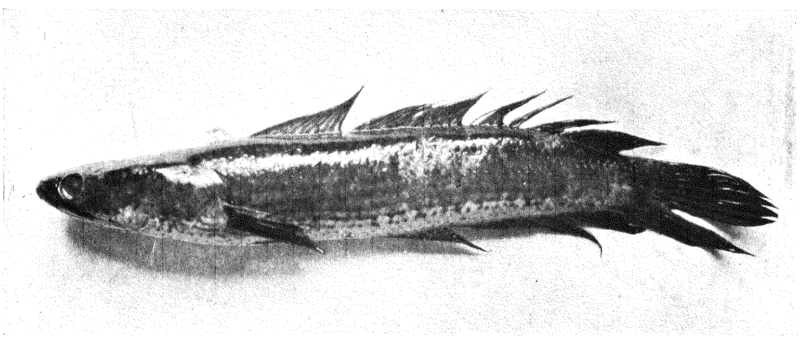

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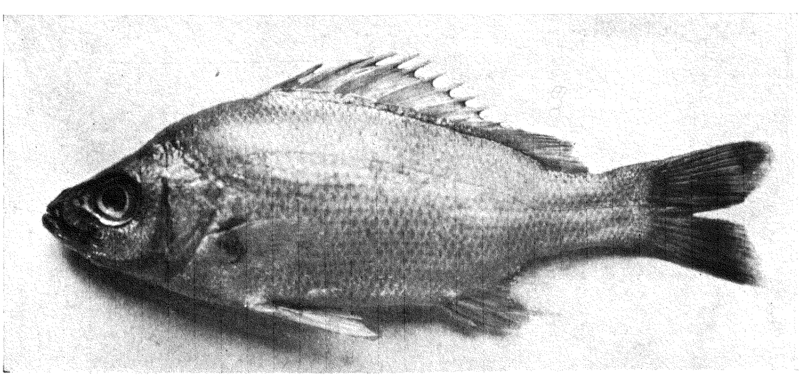

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PLATE 3.

CHIRONOMIDÆ FROM JAPAN (DIPTERA), VI
DIAMESINÆ [1]

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FOUR PLATES AND TWO TEXT FIGURES

The chironomid flies reported in the present paper were mainly collected at high altitude in the Japanese Alps (Plate 4, fig. 30) by Mr. K. Imanishi. In addition to these mountain species some specimens collected by myself at Kyoto are also described. The taxonomic system adopted in this report is based mainly on that of Edwards (1929), supplemented by that of Goetghebuer (1932).

I express here my hearty thanks to the director, Prof. Hachiro Yuasa, for his cordial help in this work. I am also greatly indebted to Mr. Kinji Imanishi for his continued interest in making known the rich chironomid fauna of the Japanese Alps. I am likewise indebted to Mr. Shigeo Hosono and Mr. Kiyoji Tsutsui for several mountain specimens.

The "antennal ratio" shows the relative length of the ultimate antennal segment to that of the remaining segments, excepting the scape, taken together. The "leg ratio" of the foreleg shows the relative length of the first tarsal segment to that of the tibia. Terminology for wing venation and corresponding abbreviations are given in Plate 1, fig. 5.

Key to the species of Japanese Diamesinæ.

[Genera and subgenera with asterisks have not been found in Japan.]

1. M_{3+4} anastomosing with Cu_1 at its deflecting part, m-cu absent. (*Prodiamesa* Kieffer.) .... 2.
   M_{3+4} not anastomosing with Cu_1 at its deflecting part, m-cu present. 5.
2. Wings with macrotrichia at least on distal membrane. (Subgenus *Trichodiamesa* Goetghebuer.)*
   Wings without macrotrichia on membrane .... 3.
3. Styles double .... (Subgenus *Prodiamesa* Kieffer.)*
   Styles simple. (Subgenus *Monodiamesa* Kieffer.) .... 4.

[1] Contribution from the entomological laboratory, Kyoto Imperial University, No. 50.

4. Coxites with double, setigerous, basal lobes; fourth tarsal segments cylindrical, longer than fifth; antennal ratio about 2.8.
P. (*M.*) *bathyphila* Kieffer.
Coxites with simple, nonsetigerous, basal lobes; fourth tarsal segments cordiform, shorter than fifth; antennal ratio about 0.1.
P. (*M.*) *brevitarsis* sp. nov.
5. Fourth tarsal segments cylindrical .... 6.
Fourth tarsal segments cordiform or bilobate at tip........ 12.
6. Coxites produced far caudad beyond insertion of styles.
(*Protanypus* Kieffer.) *
Coxites not produced far caudad beyond insertion of style. (*Syndiamesa* Kieffer.) .... 7.
7. Wings with macrotrichia at least on distal membrane. (Subgenus *Lasiodiamesa* Kieffer.) .... *S.* (*L.*) *nivis* sp. nov.
Wings without macrotrichia on membrane. (Subgenus *Syndiamesa* Kieffer.) .... 8.
8. Middle and hind tarsi with apical spurs on each of first two segments .... 9.
Middle and hind tarsi with apical spurs on each of first three segments .... 10.
9. Third segment of maxillary palpus distinctly produced beyond insertion of fourth segment .... *S.* (*S.*) *takatensis* sp. nov.
Third segment of maxillary palpus not produced beyond insertion of fourth segment .... *S.* (*S.*) *lanceolata* sp. nov.
10. Pronotum setigerous at least at side .... 11.
Pronotum not setigerous .... *S.* (*S.*) *kashimæ* sp. nov.
11. Fourth tarsal segment of foreleg longer than fifth.
S. (*S.*) *montana* sp. nov.
Fourth tarsal segment of foreleg shorter than fifth.
S. (*S.*) sp. (No. 1).
12. Dorsocentral hairs of thorax either absent or very small, decumbent, not arising from large punctures at their bases.
(*Heptagyia* Philippi.) *
Dorsocentral hairs of thorax present, long, suberect, arising from large punctures at their bases. (*Diamesa* Meigen.)........ 13.
13. Tibia of foreleg shorter than basitarsus; eyes bare.
(Subgenus *Potthastia* Kieffer.) *
Tibia of foreleg longer than basitarsus; eyes pubescent or bare........ 14.
14. Eyes bare. (Subgenus *Psilodiamesa* Kieffer.) *D.* (*P.*) *nigatana* sp. nov.
Eyes pubescent. (Subgenus *Diamesa* Meigen.) .... 15.
15. Frontoclypeus bare; styles immovable .... *D.* (*D.*) *astyla* sp. nov.
Frontoclypeus setigerous; styles movable .... 16.
16. Eyes with minute dotlike pubescence .... *D.* (*D.*) sp. (No. 2).
Eyes with normal long pubescence .... 17.
17. Each of three proximal tarsal segments of each leg provided with apical spurs .... 18.
Each of two proximal tarsal segments of each leg provided with apical spurs .... 19.

18. Costa of wing produced beyond tip of R_{4+5}; antennal ratio of male 0.4 to 0.6 .... *D.* (*D.*) *japonica* sp. nov.
    Costa of wing not produced beyond tip of R_{4+5}; antennal ratio of male 0.8 .... *D.* (*D.*) *alpina* sp. nov.
19. Male antennæ not plumose; antennal ratio of female 0.4 to 0.5. *D.* (*D.*) *tsutsuii* sp. nov.
    Male antennæ plumose; antennal ratio of female more than 0.5.... 20.
20. Crossvein r-m distinctly curved .... *D.* (*D.*) sp. (No. 1).
    Crossvein r-m almost straight .... *D.* (*D.*) *plumicornis* sp. nov.

PRODIAMESA (MONODIAMESA) BATHYPHILA Kieffer.

KIEFFER, Ent. Mitteil. 7 (1918) 102; GOETGHEBUER, Faune de France 23 (1932) 151.

This fly was collected on a glass window in April at Shibutani, Higashiyama, Kyoto. The details of structure of this fly are little known, so a redescription of this species, based on the Japanese male specimen, is given below:

Body entirely black, 7 mm in length, distinctly setigerous in general appearance. Eyes extended narrowly dorsad around the antennal bases, not pubescent; antennæ 14-segmented, highly plumose with long dark setæ; antennal ratio 2.8; maxillary palpi 5-segmented (3 : 5 : 9 : 10 : 13). Pronotum distinctly separated into lateral halves, well developed, without setæ, each half pale brown on dorsomesal region; scutum slightly pruinose, with three shining vittæ, with paired setal rows on the pruinose areas between median and lateral vittæ, without median setal row; setæ all black, without pale basal punctures of the integument; supra-alar setal group represented by seven or eight small black setæ; humeral pits deep, elongate; scutellum black, highly setigerous; postscutellum also entirely black.

Abdomen beset with long black setæ which arise from pale basal punctures. Hypopygium (Plate 1, fig. 2) black, hairy; ultimate tergum setigerous on caudal margin with small setæ, provided with small anal point which is not strongly thickened, pubescent on proximal half; ultimate sternum very narrow; coxites large, elongate, hairy with many long setæ, each provided with about seven slender setæ on ventromesal chitinized ridge, a blunt, hairy projection on proximal region and two broad, fleshy, hairy projections on middle region; styles not double, with minute setæ, thickened on ventral side, each with a chitinized rodlet and two small spines at tip.

Legs brown, pale brown only at proximal end of each femur; fourth tarsal segments cylindrical, longer than fifth; fore tibia with a spur which is slender, bare, slightly longer than diameter of tibial end; tarsal segments of foreleg without apical spurs; proportional lengths of segments of foreleg, excepting coxa and trochanter, showing 80 : 105 : 87 : 83 : 31 : 20 : 12; leg ratio about 0.8; middle and hind tibiæ each with two spurs of which the longer one is as long as diameter of tibial end; comb of hind tibia consisting of about eleven spines; proximal two tarsal segments of middle and hind legs each with two, strong, apical spurs; proportional lengths of distal two tarsal segments of hind leg 17 : 7; claws strong, slightly spatulate and obscurely pectinate at end.

Wings hyaline, without macrotrichia, slightly milky white by reflected light; anterior veins and stem of M and Cu_1 much darkened; costa produced beyond end of R_{4+5}; R_{2+3} ending on costa at middle between ends of R_1 and R_{4+5}; m-cu absent; M_{3+4} and Cu_1 anastomosing for a short distance. Halteres yellowish white; stems brown.

Specimen.—Alcoholic male; wing, legs, and hypopygium mounted in euparal; Shibutani, Higashiyama, Kyoto; April 4, 1932; deposited in the entomological laboratory of Kyoto Imperial University; collected by M. Tokunaga.

This Japanese specimen is somewhat different from the European specimens in the coloration of various parts, but these differences may be local variations.

PRODIAMESA (MONODIAMESA) BREVITARSIS sp. nov.

This fly was captured at a light screen set by a rapid stream at Kibune, Kyoto.

Male.—Body entirely black, about 2.8 mm in length; wings about 2 mm in length; halteres yellowish brown. Eyes bare; antennæ (text fig. 1, *b*) 14-segmented; plumose hairs highly reduced; distal antennal segment very short, shorter than preceding two segments taken together, distinctly swollen distally, pubescent with small hairs; second to fourth antennal segments very short, somewhat discoidal; sixth to thirteenth segments elongate, fusiform; antennal ratio about 0.1 (4:30). Setæ of thoracic tergum small, without basal punctures on integument; pronotum with several setæ on each lateral side. Hypopygium (text fig. 1, *a*) black, without anal point; coxites slender, elongate, each with a chitinized basal lobe; styles small, not elongate, pubescent, with small setæ, each with a minute, apical

spine; ultimate tergum without strong setæ, but pubescent with minute hairs on caudal part, provided with a pair of membranous lobes on caudal margin; ultimate sternum without setæ, with a small membranous lobe on caudal margin between bases of the coxites.

Legs dark brown; tibiæ paler than other segments; tarsal spurs wanting in all legs; foreleg with one tibial spur and other legs with two; fourth tarsal segment of each leg broad, bilobate at tip, very small, half as long as fifth; relative lengths of segments of legs, excepting two proximal segments, as follows: 37 : 50 : 21 : 11 : 6 : 3 : 6 in foreleg, 47 : 48 : 23 : 13 : 7 : 3 : 6

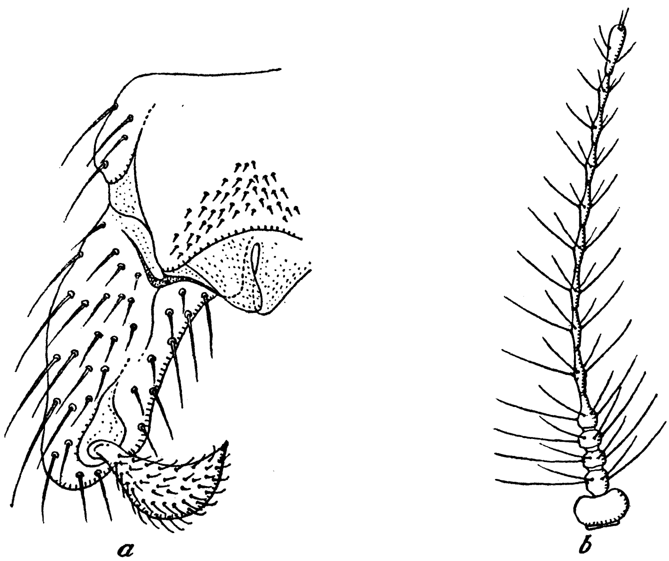


FIG. 1. *Prodiamesa brevitarsis* sp. nov.; *a*, male hypopygium, dorsal aspect; *b*, male antenna.

in middle leg, and 50 : 59 : 32 : 18 : 8 : 3 : 7 in hind leg. Wings comparatively broad, brown by transmitted light, without macrotrichia on membrane; costa produced beyond end of R_{4+5}; anastomosis between M_{3+4} and Cu_1 distinct.

Habitat.—Kyoto, Japan.

Holotype.—Alcoholic male; Kibune, Kyoto; October 16, 1934; deposited in the entomological laboratory of Kyoto Imperial University; collected by M. Tokunaga.

The present species does not show certain generic characters of *Prodiamesa* given by Edwards and Goetghebuer, especially the short fourth tarsal segments, and rather resembles *Hep-*

tagyia. I decided, however, to place it under the subgenus *Monodiamesa* of the genus *Prodiamesa,* owing to the important character of the wing venation. This fly is easily distinguishable from the other related species by the extremely small value of the antennal ratio and the short, bilobate, fourth tarsal segments.

SYNDIAMESA (SYNDIAMESA) LANCEOLATA sp. nov.

This fly was captured in the botanical garden of Kyoto Imperial University, Kitashirakawa, Kyoto, in early spring.

Male.—Body about 4.5 mm in length, entirely black, hairy in general appearance. Eyes bare, extending dorsad around antennal bases and very narrowly separated from each other on dorsal side; frontoclypeus black, hairy; antennæ 14-segmented, highly plumose with dark hairs, each with a short apical seta; antennal ratio about 2 (45 : 22); scape with three, short, black setæ; maxillary palpi distinctly 5-segmented (3 : 5 : 11 : 13 : 16). Pronotum well developed, separated at middle by a deep V-shaped incision, setigerous on ventrolateral and dorsomesal margins; highly pruinose, with black setæ along pseudosutural foveæ, without middorsal setæ; supra-alar setal group consisting of about fourteen black setæ; scutellum black, setigerous all over the surface; postscutellum entirely black, bluntly projecting dorsad at caudal end; thoracic setæ not arising from pale basal punctures.

Abdomen entirely black, with numerous pale setigerous punctures. Hypopygium (Plate 1, fig. 1) black, setigerous; ultimate tergum broad, subdivided by a V-shaped chitinization into a median, triangular, nonsetigerous area and paired, lateral, setigerous areas; anal point long, sharply pointed, needlelike, slightly lanceolate, hyaline on distal half; ultimate sternum subdivided into paired, setigerous hemisternites; coxites also setigerous, broad, each with a fleshy, setigerous projection on proximal side; styles extending straight, beset with short setæ, each with a minute black spine within a minute apical concavity.

Legs entirely brownish black; fourth tarsal segments of all legs cylindrical; foreleg with the following proportional lengths of segments: 85 : 105 : 82 : 41 : 26 : 12 : 10; leg ratio about 0.8; tibial spur of foreleg pubescent, very slightly longer than diameter of tibial end; fore tarsal segments without apical spurs; tibiæ of middle and hind legs each with two, apical, pubescent spurs, those of middle leg subequal in length to each other, those of hind leg unequal, the mesal being longer than the other and

slightly longer than diameter of tibial end; tibial comb of hind leg consisting of about twelve strong setæ; proximal two tarsal segments of middle and hind legs each provided with two apical spurs; distal two tarsal segments of hind leg subequal in length. Wings without macrotrichia; costa distinctly produced beyond end of R_{4+5}; m-cu present, very short; squama brownish black, with brown fringe. Halteres entirely dark brown.

Habitat.—Kyoto, Japan.

Holotype.—Alcoholic male; legs and hypopygium mounted in euparal; March 31, 1932; deposited in the entomological laboratory of Kyoto Imperial University; collected by M. Tokunaga.

Although this species is slightly different from the other known members of the genus *Syndiamesa* in the setigerous pronotum and absence of the apical spurs of third tarsal segments of all legs, in other structures it is similar to *S. vidua* Kieffer and *S. nivicola* Bezzi, excepting the characteristic value of the antennal ratio and the proportional lengths of the leg segments.

SYNDIAMESA (SYNDIAMESA) TAKATENSIS sp. nov.

This description is based on a single specimen of a male fly found in the collection made on snow in spring at Takata, Nigata Prefecture, and labeled *Chironomus takadensis* Matsumura, collectively, for four different insects; namely, two species of *Spaniotoma, Diamesa japonica,* and the present fly. The species incorrectly named by Matsumura is thought to be a species of *Spaniotoma,* judging from the wing venation figured by Sueo Izumi.[2]

Male.—Body about 5.8 mm in length, entirely black, not so highly hairy as in the former species. Eyes bare, reniform, widely separated from each other on dorsal side; distance between them subequal to vertical lengths of eyes, or 0.42 times as wide as head width. Antennæ 14-segmented, highly plumose; antennal ratio about 2.84. Maxillary palpi 5-segmented (4: 6: 15: 17: 18); middle segment distinctly produced dorsodistad beyond insertion of following fourth segment. Pronotum setigerous only at side; scutum setigerous; supra-alar setal group represented by about sixteen black setæ; thoracic setæ arising from pale punctures. Hypopygium black, setigerous; ultimate tergum with a small, needlelike, black, anal point; coxites slender, without basal lobes, not distinctly produced beyond insertion

[2] Insects on snow. Investigations of snow, No. 1 (1929).

of styles; styles comparatively slender, each with a long black spine and many strong apical bristles.

Legs entirely black; fore tarsal segments broken off; proximal two tarsal segments of middle and hind legs each provided with two apical spurs; fourth tarsal segments cylindrical, longer than ultimate segments, and showing the following proportional lengths between them: 10 : 9 in middle leg and 12 : 10 in hind leg. Wings and halteres as in the former species.

Habitat.—Takata, Japan.

Holotype.—Alcoholic male; deposited in the entomological laboratory of Kyoto Imperial University; data of collection obscure on label.

This species is related to the former species, but distinctly different in the characteristic structure of the maxillary palpi, widely separated eyes, and structure of the hypopygium.

SYNDIAMESA (SYNDIAMESA) MONTANA sp. nov.

This species was captured at Tsurugisawa in the Japanese Alps, altitude about 2,400 to 2,700 meters.

Male.—Body length about 5.3 mm; wing expanse about 9 mm; color entirely dark brown. Head small, 0.75 mm in width, beset with short black setæ; eyes reniform, bare, widely separated from each other; antennæ highly plumose, 14-segmented; distal segment elongate, slightly clavate, with an apical hair; antennal ratio about 1.65; scape large, with a sensory pore and three small setæ; maxillary palpi 5-segmented, including small, proximal, nonsetigerous segment (4: 7.5: 13: 14.5: 16); third palpal segment somewhat swollen ventrad, with a sensory pore.

Thorax brownish black; pronotum setigerous only at side; scutum without middorsal setæ; setæ along pseudosutural foveæ directly arising from dark integument; scutellum setigerous all over the surface. Abdomen dark brown, with brown hairs on dorsal side. Hypopygium (Plate 1, fig. 4) setigerous; ultimate tergum with a short cylindrical anal point, without distinct hairs; coxites large, each with a small setigerous projection on distomesal margin; styles large, each with a tiny tooth at tip.

Legs entirely brown; claws slightly spatulate, each with seven minute teeth at tip; two tibial spurs on each middle and hind leg and one on foreleg; these spurs sharply pointed, large, swollen on proximal region, pubescent basally; tibial comb of hind leg composed of about sixteen strong setæ; proximal three tarsal segments of each leg provided with apical spurs; segments of hind leg showing the following proportional lengths:

123 : 141 : 94 : 47 : 36 : 16 : 14; leg ratio about 0.66; fourth tarsal segment of middle and hind legs shorter than fifth, the ratio being 11 : 13 in middle leg and 14 : 15 in hind leg. Wings hyaline, slightly brown, without macrotrichia; anal lobe almost rectangular, squama thickly fringed; main veins brown; Sc ending on costa at opposite side of end of Cu_1; R_{2+3} extending along center between R_1 and R_{4+5} ending nearer R_{4+5} than R_1; relative lengths of R_1 and R_{4+5} about 16: 27; r-m thrice as long as first section of M_{3+4}, strong, oblique, straight; m-cu one-third as long as first section of M_{3+4}; costa produced along wing margin beyond end of R_{4+5}; this prolongation one-fourth as long as distance between ends of R_{4+5} and M_{3+4}. Halteres yellowish white.

Male pupa.—Body about 6.5 to 7 mm in length; exuviæ brown; abdomen entirely covered with minute dotlike spinules, without tubercles and swimming hairs. Head with a blunt median projection on vertex, one pair of strong setæ on vertex behind antennal bases and two pairs of small setæ on marginal ridges of genæ behind the regions of compound eyes. Thorax with a long seta on each lateral half of pronotal region, one pair of double setæ on cephalic margin of scutal region, three long setæ on lateral side caudad of pronotum, two short setæ on middle of each pseudosutural fovea; pronotal respiratory organs completely atrophied, being represented by a pair of depressions of integument; this peculiar feature of the respiratory organs is also known in *Diamesa lurida* Garrett. Each abdominal segment with thickly chitinized bands on cephalic margin, well-developed lateral expansions; these lateral expansions without pointed chitinizations on margins but each with a dark rudiment of a spiracle and four setæ; these setæ of lateral expansion all slender, very small on first five abdominal segments; one seta on ventrocaudal margin of lateral expansion of sixth segment finely branched; all setæ of seventh and eighth expansions distinctly branched (Plate 3, fig. 29); venter of each abdominal segment provided with two pairs of small setæ and dorsum, excepting that of eighth, with four pairs of minute and one pair of slender setæ; ultimate segment (Plate 3, fig. 28) semicircular from dorsal aspect, deeply incised at caudomesal margin, with paired dark tubercles and setal groups, each of which consists of three very long slender setæ on caudal margin; one pair of branched setæ on margin of a V-shaped caudal incision; genital sheaths deeply bilobate, extending beyond caudal margin of ninth segment between tubercles.

In general appearance the present pupa somewhat resembles that of *Syndiamesa branickii* Nowicki, but is distinctly different in the absence of filiform prothoracic respiratory organs, absence of dorsal chitinized patches of anterior abdominal segments, and presence of the comparatively long anal setæ.

Habitat.—Japanese Alps, Japan.

Holotype.—Alcoholic male; legs mounted in euparal; Tsurugisawa, Toyama Prefecture; October 17, 1928; deposited in the entomological laboratory of Kyoto Imperial University; collected by Mr. K. Imanishi.

The setigerous pronotum and shorter fourth tarsal segments of the middle and hind legs are thought to be peculiar for this genus but not rare among the Japanese species of *Syndiamesa.* This species is related to *Syndiamesa hygropetrica* Kieffer and *S. macronyx* Kieffer in the structure of the legs and hypopygium, respectively, but in the structure of the antennæ distinctly different from these related species.

SYNDIAMESA (SYNDIAMESA) KASHIMÆ sp. nov.

This fly was found on the spring snow at Kashima, Japanese Alps, Nagano Prefecture, about 1,600 meters in altitude.

Male.—Body length 5.7 mm; wing expanse 9 mm; thorax dark brown, abdomen and legs pale brown (immature?). Head large about 1 mm in width, entirely dark brown, including antennæ and mouth parts; occiput setigerous with black setæ; eyes bare, widely separated from each other; frontoclypeus with many long dark hairs; antennæ 14-segmented, densely plumose with long black hairs; scape with two setæ on ventral side; proximal eleven segments of flagellum very short, ring-shaped, each with about fifteen long plumose hairs; distal segment with a short apical seta; antennal ratio 3 (60 : 21); maxillary palpi 5-segmented (4 : 11 : 17.5 : 21 : 22).

Pronotum quite bare; scutum with many long black setæ along pseudosutural foveæ, without middorsal setæ; scutellum pale brown, highly setigerous. Abdomen highly setigerous with long black setæ on dorsum, nonsetigerous on venter. Hypopygium (Plate 1, fig. 3) distinctly darker, more setigerous than other segments; distinct projection of coxites wanting; styles comparatively slender, each with three tiny teeth on distal margin, without distinct bristles; ultimate tergum membranous, setigerous, with broad, pubescent, anal point.

Legs pale brown, highly setigerous; coxæ, trochanters, distal ends of all leg segments, articulations between femora and tibiæ,

and distal tarsal segments of all legs black; proximal three tarsal segments of all legs with apical spurs; tibial spurs and combs similar to those of the other species; claws each with one small seta and four or five large setæ at base, serrate into six minute teeth at tip; leg ratio of foreleg about 0.66; relative lengths of segments of foreleg 104 : 131 : 86 : 47 : 35 : 17 : 15; ultimate tarsal segments of middle and hind legs longer than penultimate, their ratio being 12 : 11 in middle leg and 15 : 14 in hind leg. Wings hyaline, without macrotrichia; anal lobe well developed; squama fringed with long setæ; main veins brown; Sc ending on costa a little before the opposite side of end of Cu_1; costa produced beyond end of R_{4+5}; this prolongation one-third as long as distance between ends of R_{4+5} and M_{1+2}; R_{2+3} extending closer to R_{4+5} than to R_1; r-m straight, about thrice as long as first section of M_{3+4}; m-cu very short, half as long as first section of M_{3+4}. Halteres white.

Habitat.—Japanese Alps, Japan.

Holotype.—Alcoholic male; legs mounted in euparal; Kashima, Nagano Prefecture; April 1, 1928; deposited in the entomological laboratory of Kyoto Imperial University; collected by Mr. K. Imanishi.

This species resembles *Syndiamesa hygropetrica* Kieffer in the structure of the male hypopygium, but differs distinctly in the narrow, ring-shaped, intermediate, flagellar segments of the antennæ.

SYNDIAMESA (LASIODIAMESA) NIVIS sp. nov.

This species is often found on the spring snow and has been captured at various places from an altitude of 900 to 1,300 meters in the Japanese Alps.

Female.—Body length about 6.8 mm; wing expanse about 14 mm; general color black. Head capsule reniform in frontal aspect, 0.84 mm in width; eyes bare, occupying two-thirds of head, widely separated from each other; frontoclypeus highly setigerous with long silky white hairs; antennæ 7-segmented (6 : 7 : 5.2 : 5 : 4.5 : 4.3 : 13.5), with long stiff verticils; scape with five setæ on ventral side; pedicel pale on proximal part, with many verticils arranged in two rings; intermediate segments of flagellum, from first to fourth, elongate, barrel-shaped, each with four to six stiff verticils; distal segment elongate, fusiform, with one short verticil on dorsal side and three apical hairs, equal in length to preceding three segments taken together;

maxillary palpi large, far longer than antennæ, 5-segmented (4 : 10 : 16 : 19 : 24). Pronotum setigerous on both dorsal and lateral sides; scutum with many setæ along pseudosutural foveæ, without middorsal setæ; scutellum beset with long silky hairs. Abdomen dark brown, setigerous; ultimate sternum also highly setigerous; ultimate tergum subdivided into paired setigerous hemitergites by a median membrane; cerci large, elongate, and curved ventrocephalad; spermathecæ three, discoidal, without colored ducts or necks.

Legs entirely dark brown; tibial spurs as usual in other members of this genus; tibial comb of hind leg consisting of about seventeen large bristles; foreleg with the following proportional lengths of segments: 120 : 150 : 102 : 57 : 42 : 22 : 20; leg ratio about 0.68; all tarsi provided with apical spurs on each of proximal three tarsal segments; fifth tarsal segment of middle leg equal in length to fourth (16 : 16) and that of hind leg slightly shorter than fourth (19 : 20). Wings hyaline, with macrotrichia on distal parts of cells R_5, M_2, and M_4; squama densely fringed; anal lobe almost rectangular; main veins brown; Sc ending on costa at opposite side of end of Cu_1; R_{2+3} ending at middle of wing margin between ends of R_1 and R_{4+5}; relative lengths of R_1 and R_{4+5} about 3 : 5; m-cu half as long as first section of M_{3+4}; r-m straight, thrice as long as first section of M_{3+4}; costa very slightly beyond end of R_{4+5}. Halteres yellow.

Habitat.—Japanese Alps, Japan.

Holotype.—Female; wing and legs mounted in euparal; Haruizawa, Nigata Prefecture; April 2, 1928.

Paratypes.—Females; Tsubame and Sasagamine, Nigata Prefecture, and Kashima, Nagano Prefecture; March 29 and 30 and April 1, 1928.

Type specimens.—Alcoholic; deposited in the entomological laboratory of Kyoto Imperial University; collected by Mr. K. Imanishi.

This species resembles *Syndiamesa borealis* Kieffer, but differs in the presence of the macrotrichia on the wing membrane and in the elongate, barrel-shaped, antennal segments. The macrotrichia are also present on the wings of *S. pilosa* Kieffer, but in this species they are found only at the tip of cells R_5 and M_2.

SYNDIAMESA (SYNDIAMESA) sp. (No. 1).

This fly was captured at Sasagamine, Japanese Alps, about 1,300 meters in altitude.

Female.—Body about 5.5 mm in length, ground color black; wing expanse about 12 mm. Eyes bare, widely separated from

each other; distance between them more than one-third of head width on dorsal side; antennæ 8-segmented, with many black verticils; scape with four setæ on ventral side; pedicel elongate, barrel-shaped, with about twelve hairs; proximal five segments of flagellum subequal in length to each other; each segment of flagellum, excepting distal one, somewhat pitcherlike; distal segment as long as preceding two segments taken together, fusiform, with two apical setæ; antennal ratio about 0.35. Pronotum setigerous at side. Wings without macrotrichia; costa slightly produced beyond end of R_{4+5}; relative lengths of veins R_1 and R_{4+5} about 30 : 54; r-m straight, four times as long as first section of M_{3+4}. Tibial comb of hind leg composed of about nineteen setæ; fourth tarsal segments of all legs shorter than fifth, being 15 : 19 in foreleg, 11.5 : 17.5 in middle leg, and 15 : 19 in hind leg; leg ratio of foreleg about 0.63; proximal three tarsal segments of each leg with apical spurs. Hypopygium darker than other abdominal segments; cerci triangular, pointed caudad; eighth sternum setigerous, with a deep caudal incision; ninth tergum thickened at side, with soft setæ; spermathecæ three, agreeing with those of *Syndiamesa nivis*.

Habitat.—Japanese Alps, Japan.

Specimen.—Alcoholic female; legs mounted in euparal; Sasagamine, Nigata Prefecture; March 26, 1928; collected by Mr. K. Imanishi.

This fly is allied to *Syndiamesa macronyx* Kieffer, but is distinctly different in the black coloration.

DIAMESA (PSILODIAMESA) NIGATANA sp. nov.

This fly was captured on the spring snow at Sasagamine, Nigata Prefecture, Japanese Alps, about 1,300 meters in altitude.

Male.—Body about 6 mm in length, ground color black. Head dark brown, including antennæ, mouth parts, and maxillary palpi; eyes bare, reniform, widely separated from each other; antennæ highly plumose, 14-segmented; antennal ratio about 3.35; maxillary palpi 5-segmented, including small, basal, nonsetigerous segment (3 : 6 : 10 : 12 : 20).

Thorax deep black; pronotum slightly setigerous at side; scutum slightly pruinose, with paired, lateral, setigerous lines along pseudosutural foveæ, without middorsal setæ; setæ of scutum not arising from pale basal punctures of integument; supra-alar setal group represented by about ten black setæ. Both sides of abdomen dark brown, thickly beset with long black setæ, which

arise from pale basal punctures. Hypopygium (Plate 2, fig. 10) simple, setigerous; ultimate tergum membranous, setigerous only on lateral halves, without anal point; coxites elongate, setigerous, projected mesad on ventroproximal edge, without other distinct setigerous projections; styles also beset with small setæ, flattened, each with a minute, apical tooth and several minute, branched setæ on apex.

Legs entirely dark brown; proportional lengths of segments of foreleg 76 : 87 : 60 : 36 : 21 : 11 : 9; leg ratio about 0.69; tibia of foreleg with an apical spur, which is basally pubescent and as long as diameter of tibial end; first tarsal segment of foreleg with apical spurs; second tarsal segment with preapical spurs a little before tip; other three tarsal segments of foreleg without spurs; tibiæ of middle and hind legs each with two basally pubescent spurs, of which a longer one in the case of the middle leg is subequal to, and in the case of the hind leg is slightly longer than, diameter of tibial end; comb of hind leg consisting of about fourteen strong bristles; proximal three tarsal segments of middle and hind legs each with small spurs on ventral side in addition to apical spurs; fourth tarsal segment of each leg somewhat longer than fifth, slightly constricted beyond middle, distinctly flattened to an oval shape distad of the constriction; ratio between two distal segments of hind tarsus about 14 : 12, fourth being longer than fifth. Wings hyaline, without macrotrichia on membrane; m-cu very short; r-m curved; R_1 and R_{4+5} not swollen. Halteres dark brown.

Habitat.—Japanese Alps, Japan.

Holotype.—Male; head, legs, wings, and hypopygium mounted in euparal; Sasagamine, Nigata Prefecture; March 9, 1932.

Type specimen.—Alcoholic; deposited in the entomological laboratory of Kyoto Imperial University; collected by Mr. K. Imanishi.

This fly is of an intermediate form between the genera *Syndiamesa* and *Diamesa,* having the following characters of the former genus: Fourth tarsal segment longer than fifth and three proximal segments of the middle and hind tarsi spurred. This fly has the following characters of the latter genus: Setigerous pronotum, flattened fourth tarsal segments, and two proximal segments of the fore tarsus spurred; but this fly is placed in *Diamesa,* and not in *Syndiamesa,* owing to the important character of the flattened fourth tarsal segments. These intermediate characters will serve to distinguish the present species from other related species of *Diamesa.*

DIAMESA (DIAMESA) ALPINA sp. nov.

This species was captured at Tsurugisawa, Japanese Alps, 2,400 to 2,700 meters in altitude (Plate 4, fig. 30), on the new snow in October and at Kakogawa, 1,500 to 1,600 meters in altitude, on the spring snow. The adults of this species are commonly found on the mountain snow in association with a certain nival stonefly, *Capnia nivalis* Ueno. Sometimes many larvæ, pupæ, and imagines of this species were found in the stomach of a torrential fish, *Salvelinus pluvius,* captured in Kashima River, 1,000 to 1,500 meters in altitude, October 13, 1930. The gelatinous cords of egg masses were found along the stream adhering to various substrata, such as wet stones, twigs, etc. The eggs are arranged in two longitudinal lines within the gelatinous matrix (Plate 4, fig. 32). Among the material taken from the stomach of a fish, I found many copulating pairs of which the females were almost always pale in color and their wings and legs not fully extended, indicating that they were pairing immediately after emergence.

Male.—Body 2.5 to 3 mm in length, ground color dark brown, not highly setigerous in general appearance; wing expanse 6.5 to 7 mm; wings slightly clouded. Eyes reniform, widely separated from each other on dorsal side, distinctly pubescent; distance between them greater than one-third of head width or slightly less than vertical length of eyes (12 : 16); frontoclypeus with one pair of conspicuous setæ on lateroproximal region and very rarely with two pairs; antennæ 9-segmented, with a few short verticils; scape without setæ; pedicel elongate, with about five verticils on distal part, thrice as long as width, paler on proximal half; first segment of flagellum with two or three short verticils; second segment with one verticil; third to fifth usually without verticils; sixth segment longer than each of preceding four segments, with about four verticils; distal segment fusiform, with four verticils on proximal region and two, short, apical setæ; antennal ratio about 0.5, varying from 0.4 to 0.6; each maxillary palpus with elongate ultimate segment and three moniliform proximal segments.

Pronotum setigerous only at side; scutum with a few short setæ along pseudosutural foveæ, these setæ arising from pale basal punctures; supra-alar setal group represented by three or four black setæ; scutellum brown, and its entire surface hairy. Hypopygium (Plate 2, fig. 8) very simple; ultimate tergum trilobate, slightly setigerous, with small setæ along caudal margin, with minute hyaline anal point; coxites elongate, large, beset

with small setæ; styles also with small setæ, each with four (3 to 5) minute black teeth and several hyaline spines at tip.

Legs entirely dark brown; fourth tarsal segment distinctly obcordate; claws simple, not serrate at tip, with about three long setæ at each base; one tibial spur on foreleg, two on each middle and hind leg; these spurs flattened and pubescent basally, bare and chitinized at tip; tibial comb of hind leg consisting of eighteen strong bristles; tarsus of each leg with minute spurs on each of the proximal three segments; the foreleg having the following proportional lengths of segments: 90 : 88 : 57 : 28 : 17.5 : 7 : 8; leg ratio about 0.64 to 0.65. Wings (Plate 1, fig. 5) broad, hyaline, clouded with gray on marginal area, without macrotrichia; main veins brown, with small setæ; costa not produced beyond end of R_{4+5}; R_1 and R_{4+5} more or less swollen distad, relative lengths between them about 10 : 17 or 10 : 19; R_{2+3} ending on costa, very close to tip of R_1; r-m very slightly curved, a little longer than three times first section of M_{3+4}; m-cu very short, equal in length to width. Halteres yellow.

Female.—Body 2.6 to 3 mm in length; wing expanse 5.2 to 7 mm. Main differences from the male as follows: Antennæ 8-segmented, with a few verticils; distal segment shorter than preceding four segments of flagellum taken together, with two short apical setæ and three verticils on proximal part; antennal ratio about 0.4; leg ratio of foreleg about 0.61, very rarely attaining 0.7; hypopygium without distinct long setæ; ultimate sternum dark, entirely pubescent, with large thickened lamellæ along caudal margin, with a small, V-shaped, caudal incision, without distinct setæ; ultimate tergum (Plate 2, fig. 11) membranous, slightly hairy at side, with a pair of small, blunt, setigerous projections on caudal margin near bases of cerci; cerci (Plate 1, fig. 6) short, somewhat rectangular, pale brown; spermathecæ two, elongate, ellipsoid, brown, without colored neck region.

Pupa.—Body 3.4 to 4 mm in length; exuviæ ochraceous, hyaline, entirely covered with minute dotlike spinules; dorsal spinous welts seven in both sexes, ventral spinous welts four in female and five in male. Vertex with strong paired setæ near antennal bases; base of antennal sheath distinctly projected cephalad, forming a characteristic tuberculous horn (Plate 3, fig. 22). Thorax with several small setæ, which are not distinct, excepting a pair of large setæ cephalad of respiratory organs; prothoracic respiratory organs small, filiform, flattened at middle, not pubescent (Plate 3, fig. 23). In both sexes one dorsal spinous

welt on each abdominal segment from second to eighth, in female one ventral welt on each segment from fourth to seventh, and in male on each segment from fourth to eighth, thus making the general characters of the present pupa different from those of *Diamesa* pupæ as described by Potthast,[3] in the absence of the ventral welt of third abdominal segment; spines of dorsal welts small, dark, solid, conical, not curved backwards; those of ventral welts smaller than those of dorsal welts; number of spines varying in different segments, individuals, and sexes from twelve to fifteen on dorsal welts and from twenty to twenty-four on ventral welts, excepting those of modified eighth segment; typical arrangement of abdominal setæ as follows: Five pairs of small setæ on each dorsum, four pairs of small setæ on each venter, and a minute and three large setæ on each lateral expansion; lateral expansion comparatively narrow, provided with a rudiment of spiracle on dorsocephalic region and a very small pointed projection on caudal margin; eighth segment provided with two large setæ on each small lateral expansion, two pairs of small setæ on each lateral side of dorsum and venter; in female dorsal welt consisting of only about ten spines, and ventral wall of this segment expanded caudad forming a large swollen part of genital sheath; in male ventral welt of eighth segment composed of eight or ten spines; ultimate segment somewhat semielliptical from dorsal aspect, its dorsal side almost flattened, without setæ; lateral and caudal margins flattened forming lamellalike edges; caudal margin deeply constricted at meson, provided with a pair of setal groups each consisting of three, long, brown setæ; in female sheaths of hypopygium small, bilobate, not extending beyond caudal margin of ninth segment (Plate 3, figs. 20 and 21); in male hypopygial sheaths large, deeply bilobate, extending caudad far beyond caudal margin of ninth segment, then strongly curving backward, as in the *Diamesa* group in general.

Habitat.—Japanese Alps, Japan.

Holotype.—Male; Tsurugisawa, Toyama Prefecture; October 16, 1928.

Allotopotype.—Female; October 16, 1928.

Paratypes.—Males and females; head, legs, wing, and hypopygium mounted in euparal; Tsurugisawa, Toyama Prefecture; October 16 and 17, 1928, and June 14, 1935; and Kakogawa, Nagano Prefecture, April 1, 1930.

[3] Arch. Hydrobiol., Suppl.-Bd. 2 (1915) 350–361.

Type specimens.—Alcoholic; deposited in the entomological laboratory of Kyoto Imperial University; collected by Mr. K. Imanishi.

This species is related to *Diamesa borealis* Coquillett and *D. culicoides* Heeger, but differs distinctly in the dark brown or brown maxillary palpi, antennæ, scutellum, and legs of the male and the longer crossvein r-m of both sexes from the former allied species and differs in the higher value of the antennal ratio of the male from the latter species. A female specimen collected by Mr. S. Hosono at Seki, Nigata Prefecture, March 31, 1927, is slightly different from the other specimens only in the short ultimate segment of the antennæ, the antennal ratio being reduced to 0.3. This may be an aberrant form of this species.

DIAMESA (DIAMESA) JAPONICA sp. nov.

This fly was captured on the snow in the Japanese Alps, 200 to 1,600 meters in altitude.

Male.—Body about 4.1 mm in length, ground color black; wing expanse about 7.2 mm. Eyes pubescent, reniform, widely separated from each other on dorsal side; frontoclypeus with only four pairs of long setæ on lateroproximal region; antennæ 9-segmented, not plumose, with only a few short verticils, 0.54 mm in total length; scape without setæ; pedicel equal in length to following three segments of flagellum together, entirely brown, with three verticils on distal region; ultimate segment of antenna elongate, cylindrical, longer than remaining segments of flagellum together, with two small apical setæ, with six long verticils on proximal region; antennal ratio about 0.81; remaining segments of flagellum moniliform; first and second segments each with one verticil; other intermediate segments without verticils; maxillary palpi dark brown, moniliform, distinctly 5-segmented (4 : 5 : 9 : 10 : 16); distal segment pale and cylindrical.

Thorax entirely black; pronotum slightly setigerous at side; scutum without median setæ; erect black setæ along the pseudosutural foveæ arising from dorsal black punctures; scutellum sparsely beset with long black setæ. Hypopygium (Plate 2, fig. 7) with very small setæ, darker than anterior segments; ultimate tergum with a large, membranous, anal point, very sparsely setigerous along caudal margin; coxites each with a dorsomesal membranous lobe which is hardly extended to the tip of anal

point; styles with minute setæ, each provided with an apical tooth.

Legs entirely black; fourth tarsal segments obcordate, shorter than fifth; all tarsi with apical spurs on each of proximal three segments; tibial spurs highly pubescent, small, far shorter than diameter of tibial end, each with a minute chitinized tip; tibial comb of hind leg consisting of about twenty-two strong bristles; proportional lengths of segments of foreleg 116 : 109 : 63 : 30 : 19 : 7 : 10; leg ratio about 0.57 to 0.58. Wings broad, brownish under transmitted light, hyaline, clouded on margin, especially on anal margin, without macrotrichia; main veins dark brown; costa slightly produced beyond end of R_{4+5}; R_1 and R_{4+5} more or less swollen distally, their relative lengths about 23 : 37; R_{2+3} ending very close to end of R_1; r-m angulate or strongly curved, about thrice as long as first section of M_{3+4}; m-cu slightly shorter than first section of M_{3+4}; Cu_1 curved at tip. Halteres yellowish white.

Female.—Generally similar to male; body about 4 mm in length; frontoclypeus more setigerous than in male, being provided with ten pairs of setæ; antennæ more setigerous, with long verticils, 8-segmented; antennal ratio about 0.4; pedicel equal in length to following two segments taken together, with five verticils on distal region; proximal two flagellar segments each provided with about five setæ; third with three; fourth and fifth each with two; sixth with about five proximal and two long distal verticils, fusiform, equal in length to preceding three segments taken together; maxillary palpi 5-segmented (2 : 4 : 8 : 7 : 13); leg ratio of foreleg 0.57 to 0.58; tibial comb of hind leg consisting of about twenty-three setæ; ultimate tergum dark brown, very slightly setigerous, not reduced into membrane; ultimate sternum dark, very slightly setigerous at side, with only three small setæ on either side; cerci (Plate 2, fig. 12) pale at base, somewhat triangular, projected ventrad; spermathecæ two, small, spherical, brown, with brown neck. Other structures closely resembling those of male.

Pupa.—Body about 4 mm in length; exuviæ ochraceous, slightly brown on head, thorax, and caudal end; abdominal spinous welts consisting of large brown spines arranged on prominent brown ridges. Head with a pair of large setæ on vertex near bases of antennæ; projections of antennal bases very small, indistinct. Thorax with six pairs of distinct setæ:

Two pairs on pronotal region, three near respiratory filaments, and one pair on middle of scutal region; these thoracic setæ more distinct in male than in female; respiratory organs (Plate 3, fig. 24) very much elongate, filiform, not distinctly flattened at base. Abdominal spinous welts arranged on following segments: In female seven dorsal welts on segments second to eighth, and five ventral welts on segments third to seventh, and in male seven dorsal welts as in female and six ventral welts on segments third to eighth; in both sexes first ventral welts (Plate 3, fig. 25) highly reduced, only spines of lateral part remaining, each welt consisting of several large and small spines, larger ones being five to seven on one welt in male and six to nine in female; spines of ventral welts smaller, more slender than those of dorsal and slightly curved cephalad (Plate 3, figs. 26 and 27); setal arrangement of abdominal segments as in *Diamesa alpina,* but lateral expansions better developed; welts of seventh and eighth segments of female more or less reduced than in preceding segments; dorsal welts of these two segments each provided with six large spines, and ventral welt of eighth segment completely wanting; venter of eighth segment of female swollen ventrocaudad, provided with a line of minute dotlike spinules on caudal margin instead of welt. Ultimate segment of both sexes broad, somewhat trapezoid from dorsal aspect, with broad marginal ridge, deeply constricted at caudomeson, provided with a pair of setal groups on each caudal margin; these setal groups comparatively widely separated from each other, each consisting of three, long, curved setæ; structures of genital sheath as in *Diamesa* in general. Structures of abdominal spinous welts closely resembling those of *Diamesa insignipes* Kieffer, but differing in the spines of one welt being less than ten.

Habitat.—Japanese Alps, Japan.

Holotype.—Male; hypopygium mounted in euparal; Kashima, Nagano Prefecture; June 1, 1928.

Allotype.—Female; head, legs, and hypopygium mounted in euparal; Sasagamine, Nigata Prefecture; March 27, 1932.

Paratypes.—Males and females; Kinebashi, Fukui Prefecture; February 10, 1930; and Hosono, Nagano Prefecture; March 17, 1935.

Type specimens.—Alcoholic; deposited in the entomological laboratory of Kyoto Imperial University; collected by Messrs. K. Imanishi and K. Tsutsui.

This species is related to *Diamesa borealis* Coquillett and *D. culicoides* Heeger, but distinctly separated from the above two allied species by the antennal structures and coloration of the body, as in *D. alpina* Tokunaga. Another allied species, *D. waltli* Meigen, has a comparatively high value of the antennal ratio, and the antennæ of the male are 14-segmented and plumose.

DIAMESA JAPONICA var. (No. 1).

This variety was captured on the spring snow at Seki and Sasagamine, Nigata Prefecture, and closely resembles the type; it differs only in the following structures: Value of leg ratio slightly larger, being 0.56 to 0.6; nonsetigerous, ultimate sternum; rounder cerci (Plate 2, fig. 13); and nonspherical, comma-shaped spermathecæ (Plate 2, fig. 17).

Specimens.—Females; Seki and Sasagamine, Nigata Prefecture; March 26 and April 2, 1928; collected by Messrs. K. Imanishi and S. Hosono.

DIAMESA (DIAMESA) ASTYLA sp. nov.

This peculiar fly was collected on snow at Tsurugisawa, Toyama Prefecture, 1,600 to 2,000 meters in altitude.

Male.—Body small, 3 mm in length, dark brown, slightly setigerous in general appearance; wing expanse about 5.7 mm. Head oval, 0.41 mm in width; eyes reniform, hairy, very widely separated from each other; distance between eyes about three-fifths as great as total width of head; frontoclypeus pubescent but without setæ; antennæ not plumose, sparsely beset with several short verticils, about 0.42 mm in total length, resembling female antennæ of this genus in general appearance; scape without setæ; pedicel thrice as long as its width, with four short verticils on distal region; distal segment of antenna large, fusiform, equal in length to pedicel, with two very short apical setæ and three verticils on proximal region; intermediate five flagellar segments moniliform, each slightly longer than width, without verticils or with one or two; proportional lengths of antennal segments as follows: 6 : 2.2 : 2 : 2 : 2.2 : 3 : 6 : 3; antennal ratio 0.35; maxillary palpi yellowish brown, moniliform, 0.33 mm in total length; proportional lengths of segments 2 : 2.5 : 5 : 4.5 : 6.8.

Thorax dark brown; pronotum slightly setigerous at side; scutum with several pale setigerous punctures along each pseudosutural fovea, without middorsal setæ; scutellum dark brown, highly setigerous.

Legs entirely brown; tibial spurs small, far shorter than diameter of tibial end, flattened and pubescent basally, each with a minute bare tip; tibial comb of the hind leg consisting of about seventeen setæ; each of the proximal three tarsal segments of each leg with a pair of minute spurs; fourth segment of the tarsus obcordate, shorter than fifth; segments of foreleg having the proportional lengths 78 : 71 : 50 : 22 : 14 : 5.5 : 7.5; leg ratio about 0.7.

Hypopygium (Plate 2, fig. 9) peculiar in the absence of movable styles, entirely dark, beset with small setæ; ultimate tergum, subdivided by a pair of dorsal chitinizations into a median, pyriform, setigerous plate and paired, lateral, setigerous, semichitinized halves; median tergite without anal point, slightly constricted longitudinally at caudomeson, with two or four hyaline setæ on its caudal margin; coxites large, elongate, each with a small thickened pubescent tubercle at tip instead of style; this tubercle with three hyaline setæ at side; proximomesal lobes of coxites pubescent but without setæ, usually hidden under ultimate tergum.

Wings without macrotrichia; clouded at margin; main veins dark brown; costa very slightly produced beyond end of R_{4+5}; R_1 and R_{4+5} slightly swollen distally; R_{2+3} ending near tip of R_1; r-m very slightly curved, thrice as long as first section of M_{3+4}; m-cu apparently wanting, M_{3+4} being directly deflected on Cu_1. Halteres yellowish white.

Habitat.—Japanese Alps, Japan.

Holotype.—Male mounted in euparal; Tsurugisawa, Toyama Prefecture; October 16, 1928; deposited in the entomological laboratory of Kyoto Imperial University; collected by Mr. K. Imanishi.

This species differs from all the other known species of *Diamesa* by the unique character of the hypopygium of the male.

DIAMESA (DIAMESA) TSUTSUII sp. nov.

This fly was collected from the snow surface where *D. japonica, Trichocera nivalis, Capnia nivalis,* and certain snow Collembola were also found (Plate 4, fig. 31).

Male.—Body about 4.5 mm in length, entirely dark brown. Eyes pubescent; frontoclypeus setigerous with short brown setæ; antennæ 9-segmented (5 : 4.5 : 2.5 : 3 : 3 : 3 : 2.2 : 2 : 9); flagellar segments each with several short setæ; ultimate segment constricted before tip, with a short apical seta; second

antennal segment comparatively short, pale brown at proximal half; antennal ratio about 0.5. Pronotum slightly setigerous at side; mesothoracic stripes indistinct. Halteres yellowish white. Wings as in *D. japonica;* costa slightly produced beyond end of R_{4+5}; R_1 and R_{4+5} somewhat swollen; r-m curved but less than in *D. japonica* and more than in *D. alpina,* ending on base of M_{1+2}. Relative lengths of segments of foreleg 93 : 108 : 62 : 30 : 20 : 8 : 10; proximal two tarsal segments of all legs each provided with apical spurs; leg ratio about 0.57. Penultimate abdominal tergum separated into paired, lateral, subtriangular, setigerous plates; ultimate tergum (text fig. 2, *a*) with a sharply pointed anal point and paired lateral plates.

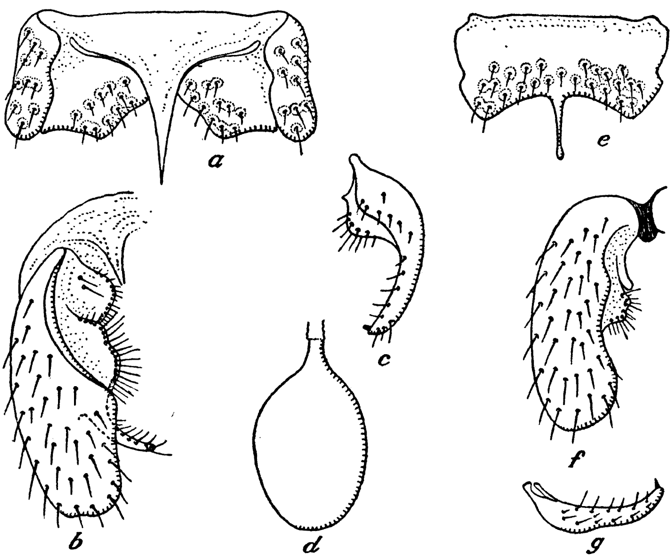


FIG. 2. *Diamesa tsutsuii* sp. nov. and *D. plumicornis* sp. nov.; *a* to *d*, *D. tsutsuii; a,* ultimate tergite; *b,* coxite, ventral aspect; *c,* style, lateral aspect; *d,* spermatheca; *e* to *g*, *D. plumicornis; e,* ultimate tergite; *f,* coxite, ventral aspect; *g,* style.

Coxites (text fig. 2, *b*) forming a large, ventral, genital chamber between thickened proximal ridges of coxites, each with three mesal lobes, of which the proximal is fringed with very small setæ and with two or three small setæ on ventral side, middle lobe large, fringed with long setæ and third lobe slender with small setæ on mesal side; two, proximal, flattened lobes forming dorsal wall of genital chamber. Style (text fig. 2, *d*) distinctly curved, with a triangular, basal projection on lateral side and a small apical spine.

Female.—Body length about 5.8 mm; antennæ 8-segmented (5 : 6 : 3.5 : 4 : 3.5 : 3.5 : 3 : 10); antennal ratio 0.42 (10 : 24); crossvein r-m ending at fork of M; proportional lengths of segments of foreleg 115 : 134 : 85 : 34 : 25 : 10 : 12; leg ratio about 0.63; penultimate abdominal tergum pale brown on caudal half; ultimate tergite subdivided into lateral halves by a narrow, median, transversal, membranous area; cerci pale brown, subtriangular; spermathecæ (text fig. 2, *d*) ovoid, with dark neck region. Other structures as in male.

Habitat.—Mountainous regions; Japan.

Holotype.—Male; Hosono (about 600 meters in altitude), Nagano Prefecture; March 17, 1935.

Allotopotype.—Female; March 17, 1935.

Type specimens.—Alcoholic; deposited in the entomological laboratory, Kyoto Imperial University; collected by Mr. K. Tsutsui.

This species is named in honor of the collector of this interesting midge. In general appearance the fly resembles *D. japonica,* but the structure of the male hypopygium is characteristic. The hypopygium is similar to that of *D. camptoneura* Kieffer, but the male antennæ are highly different in the absence of plumose hairs and the number of segments.

DIAMESA TSUTSUII (summer form ?).

This is slightly different from the type in the following characters: Body 4 to 6 mm in length; dark brown or brown in ground color; ultimate antennal segment with two, small, apical setæ; antennal ratio 0.47; leg ratio 0.68 to 0.8. Cerci (Plate 2, fig. 15) pale brown; spermathecæ as in Plate 2, fig. 19. Presumably these female specimens are the summer form.

Specimens.—Alcoholic females; Renge, Toyama Prefecture; August 15, 1931; and Kamikochi, Nagano Prefecture; July 17 to 21, 1932; deposited in the entomological laboratory of Kyoto Imperial University; collected by Mr. K. Imanishi and by Mr. Tokunaga.

DIAMESA (DIAMESA) PLUMICORNIS sp. nov.

This fly was found at Mount Hiei, Kyoto.

Male.—Body 5.5 mm in length, dark brown in ground color; abdomen brown, pale brown on the sternal side. Eyes and frontoclypeus setigerous. Antennæ 14-segmented, highly plumose, with dark hairs; each with a short apical seta; ultimate segment slightly swollen distally, with a papilliform projection at tip; an-

tennal ratio over 1 (33:31). Pronotum setigerous at side. Costa slightly produced beyond end of R_{4+5}; R_1 slightly swollen; cross-vein r-m ended on M_{1+2}, almost straight. Halteres white. Proportional lengths of segments of foreleg 82 : 96 : 66 : 31 : 20 : 7 : 8; leg ratio about 0.69; proximal two tarsal segments of each leg with apical spurs. Ultimate tergum (text fig. 2, *e*) uniformly thickened, with dark, slender, anal point, which is not sharply pointed; coxites (text fig. 2, *f*) with a setigerous mesal lobe and a minute, nonsetigerous, fingerlike lobe; style (text fig. 2, *g*) very slender, slightly curved, with a minute apical spine.

Habitat.—Kyoto, Japan.

Holotype.—Alcoholic male; Mount Hiei, Kyoto; March 17, 1935; deposited in the entomological laboratory of Kyoto Imperial University; collected by M. Tokunaga.

This fly is the only known Japanese species of the subgenus *Diamesa* that is provided with plumose antennæ. In general appearance it somewhat resembles *D. waltli* Meigen and *D. hamaticornis* Kieffer, but they are distinctly different from each other in the structure of the hypopygium and in the value of the antennal ratio.

DIAMESA sp. (No. 1).

This fly was captured at light at Renge, Japanese Alps, Toyama Prefecture, altitude, about 2,000 meters, in the summer season.

Female.—Body comparatively large, 4.5 mm in length, black in ground color. Head dark brown; eyes hairy; reniform, widely separated from each other; frontoclypeus setigerous with about twelve setæ; antennæ 8-segmented, setigerous; three verticils on scape, six on pedicel, five on first flagellar segment, four on second, three on third, four on fourth, two on fifth, and two on ultimate in addition to two, short, apical setæ; ultimate segment of antenna slightly shorter than preceding three segments together (50 : 54); antennal ratio about 0.73; maxillary palpi elongate, cylindrical, far longer than the antennæ; proportional lengths of segments 7 : 11 : 10 : 17. Pronotum setigerous at side; scutum slightly pruinose, without middorsal setæ; supra-alar setæ eight. Leg ratio of foreleg 0.7 to 0.8; relative lengths of foreleg segments 105 : 127 : 90 : 39 : 23 : 8 : 9; fourth tarsal segments lobate, shorter than fifth; tibial spurs large, not flattened basally, hardly as long as diameter of tibial end; tibial comb of hind leg consisting of about twelve setæ; each of the two proximal tarsal segments of all legs provided with a pair

of small spurs. Hypopygium setigerous; ultimate tergum subdivided by a median membrane into lateral, setigerous tergites; ultimate sternum dark, setigerous at side, with a shallow, caudal incision; cerci (Plate 2, fig. 14) projecting ventrad, pale at base; spermathecæ (Plate 2, fig. 18) two, brown, each with brown neck region. Wings without macrotrichia; costa slightly produced beyond end of R_{4+5}; R_1 and R_{4+5} more or less swollen at tip; R_{2+3} ending close to end of R_1; r-m distinctly curved; m-cu very short. Halteres yellow.

Habitat.—Japanese Alps, Japan.

Specimen.—Female; legs mounted in euparal; Renge, Toyama Prefecture; August 15, 1931; deposited in the entomological laboratory of Kyoto Imperial University; collected by Mr. K. Imanishi.

DIAMESA sp. (No. 2).

This female specimen was collected on snow at Seki, Nigata Prefecture, and has the following distinctive characters: Body length about 4.3 mm; ground color dark brown; eyes finely pubescent with minute, brown, dotlike hairs; frontoclypeus highly setigerous; antennæ 8-segmented, setigerous; scape with four setæ; ultimate segment of antenna fusiform, longer than preceding three segments together (12 : 10), with one proximal verticil and two apical setæ; antennal ratio about 0.52; segments of maxillary palpi 3 : 7 : 11 : 12 : 17 in relative lengths; wings with slightly curved r-m; halteres yellowish white; proportional lengths of segments of foreleg 99 : 122 : 84 : 40 : 24 : 9 : 16; leg ratio about 0.7; tibial comb of hind leg composed of twenty-one setæ; hypopygium as in *Diamesa* sp. (No. 1).

Habitat.—Nigata, Japan.

Specimen.—Female, head, legs, and wings mounted in euparal; Seki, Nigata Prefecture; March 23, 1928; deposited in the entomological laboratory of Kyoto Imperial University; collected by Mr. S. Hosono.

This female is closely related to *Diamesa* sp. (No. 1), but differs distinctly in the following points: Very short pubescence of eyes; more setigerous frontoclypeus, less-produced costa, slightly curved r-m, and the value of the antennal ratio.

ILLUSTRATIONS

PLATE 1

FIG. 1. *Syndiamesa lanceolata* sp. nov., male hypopygium, dorsal aspect.
2. *Prodiamesa bathyphila* Kieffer, male hypopygium, ventral aspect.
3. *Syndiamesa kashimæ* sp. nov., male hypopygium, dorsal aspect.
4. *Syndiamesa montana* sp. nov., male hypopygium, dorsal aspect.
5. *Diamesa alpina* sp. nov., male wing; *al*, anal lobe; *f*, first section of M_{3+4}; *m-cu*, mediocubital crossvein; *r-m*, radiomedial crossvein; *sc*, squama.
6. *Diamesa alpina* sp. nov., female cercus, lateral aspect.

PLATE 2

FIG. 7. *Diamesa japonica* sp. nov., male hypopygium, dorsal aspect; *ad*, appendage of coxite; *ap*, anal point.
8. *Diamesa alpina* sp. nov., male hypopygium, dorsal aspect.
9. *Diamesa astyla* sp. nov., male hypopygium, dorsal aspect.
10. *Diamesa nigatana* sp. nov., male hypopygium, dorsal aspect.
11. *Diamesa alpina* sp. nov., ultimate tergum of female, dorsal aspect.
12. *Diamesa japonica* sp. nov., female cercus, lateral aspect.
13. *Diamesa japonica* var. (No. 1), female cercus, lateral aspect.
14. *Diamesa* sp. (No. 1), female cercus, lateral aspect.
15. *Diamesa tsutsuii* (summer form ?), female cercus, lateral aspect.
16. *Diamesa japonica* sp. nov., spermatheca.
17. *Diamesa japonica* var. (No. 1), spermatheca.
18. *Diamesa* sp. (No. 1), spermatheca.
19. *Diamesa tsutsuii* (summer form ?), spermatheca.

PLATE 3

FIG. 20. *Diamesa alpina* sp. nov., female pupa, three caudal segments, dorsal aspect.
21. *Diamesa alpina* sp. nov., female pupa, three caudal segments, ventral aspect.
22. *Diamesa alpina* sp. nov., pupa, tubercle of the antennal base.
23. *Diamesa alpina* sp. nov., pupa, prothoracic respiratory organ.
24. *Diamesa japonica* sp. nov., pupa, prothoracic respiratory organ.
25. *Diamesa japonica* sp. nov., pupa, ventral spinous welt of third abdominal segment, caudal aspect.
26. *Diamesa japonica* sp. nov., pupa, ventral spinous welt of fifth abdominal segment, caudal aspect.
27. *Diamesa japonica* sp. nov., pupa, dorsal spinous welt of fifth abdominal segment, caudal aspect.
28. *Syndiamesa montana* sp. nov., male pupa, ultimate segment, dorsal aspect.

FIG. 29. *Syndiamesa montana* sp. nov., male pupa, branched seta of lateral expansion of eighth abdominal segment.

PLATE 4

FIG. 30. Tsurugisawa, Japanese Alps, spring season. *Syndiamesa montana, Diamesa alpina,* and *D. astyla* were found on the snow in company with *Capnia nivalis* Ueno.

31. Hosono, Nagano Prefecture, spring snow. *Diamesa japonica, D. tsutsuii, Trichocera nivalis, Capnia nivalis, Capnia* sp., and snow Collembola were found on the snow surface of the forest zone.

32. Egg cords of *Diamesa alpina* adhering to a twig found at margin of a torrent.

TEXT FIGURES

FIG. 1. *Prodiamesa brevitarsis* sp. nov.; *a,* male hypopygium, dorsal aspect; *b,* male antenna.

2. *Diamesa tsutsuii* sp. nov. and *D. plumicornis* sp. nov.; *a* to *d, D. tsutsuii; a,* ultimate tergite; *b,* coxite, ventral aspect; *c,* style, lateral aspect; *d,* spermatheca; *e* to *g, D. plumicornis; e,* ultimate tergite; *f,* coxite, ventral aspect; *g,* style.

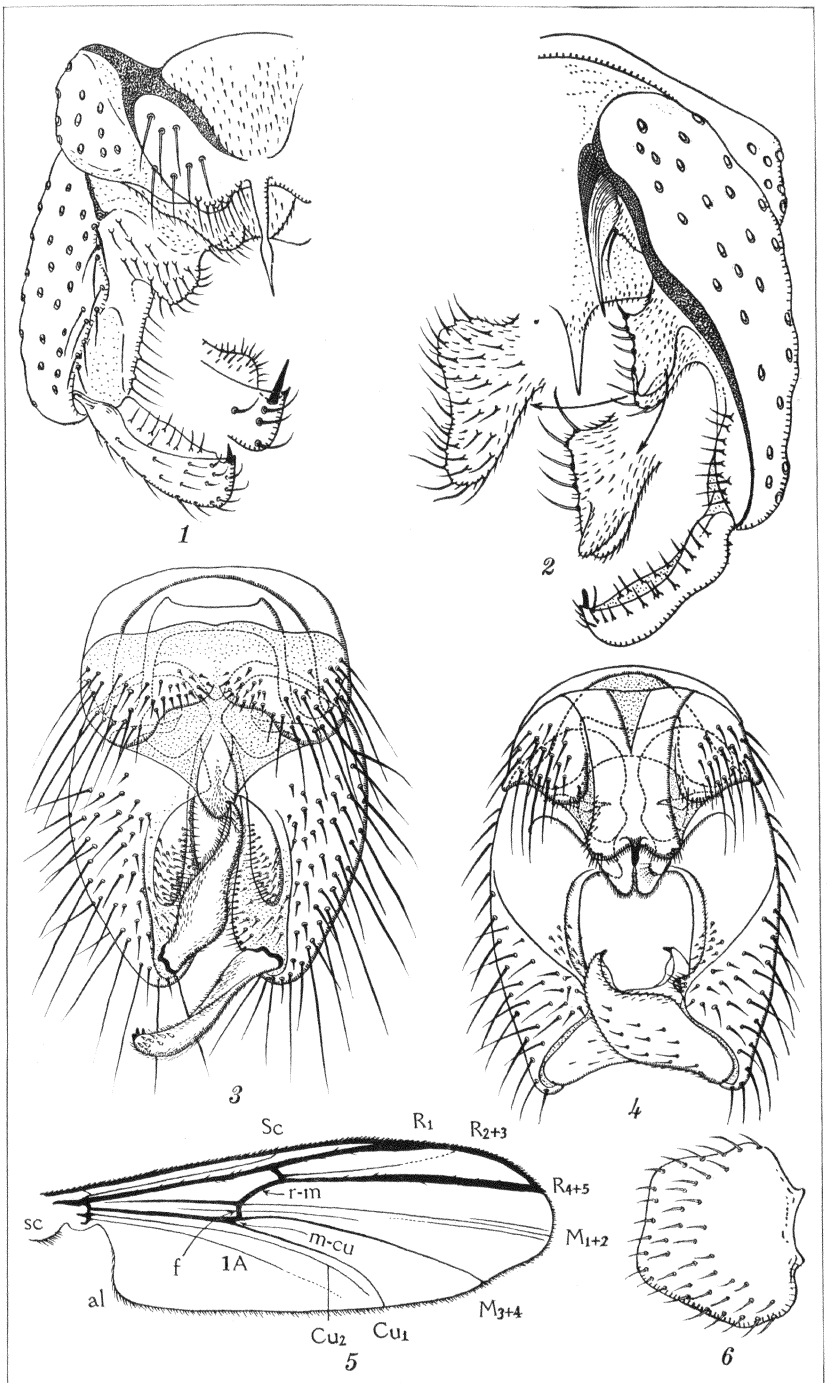


PLATE 1.

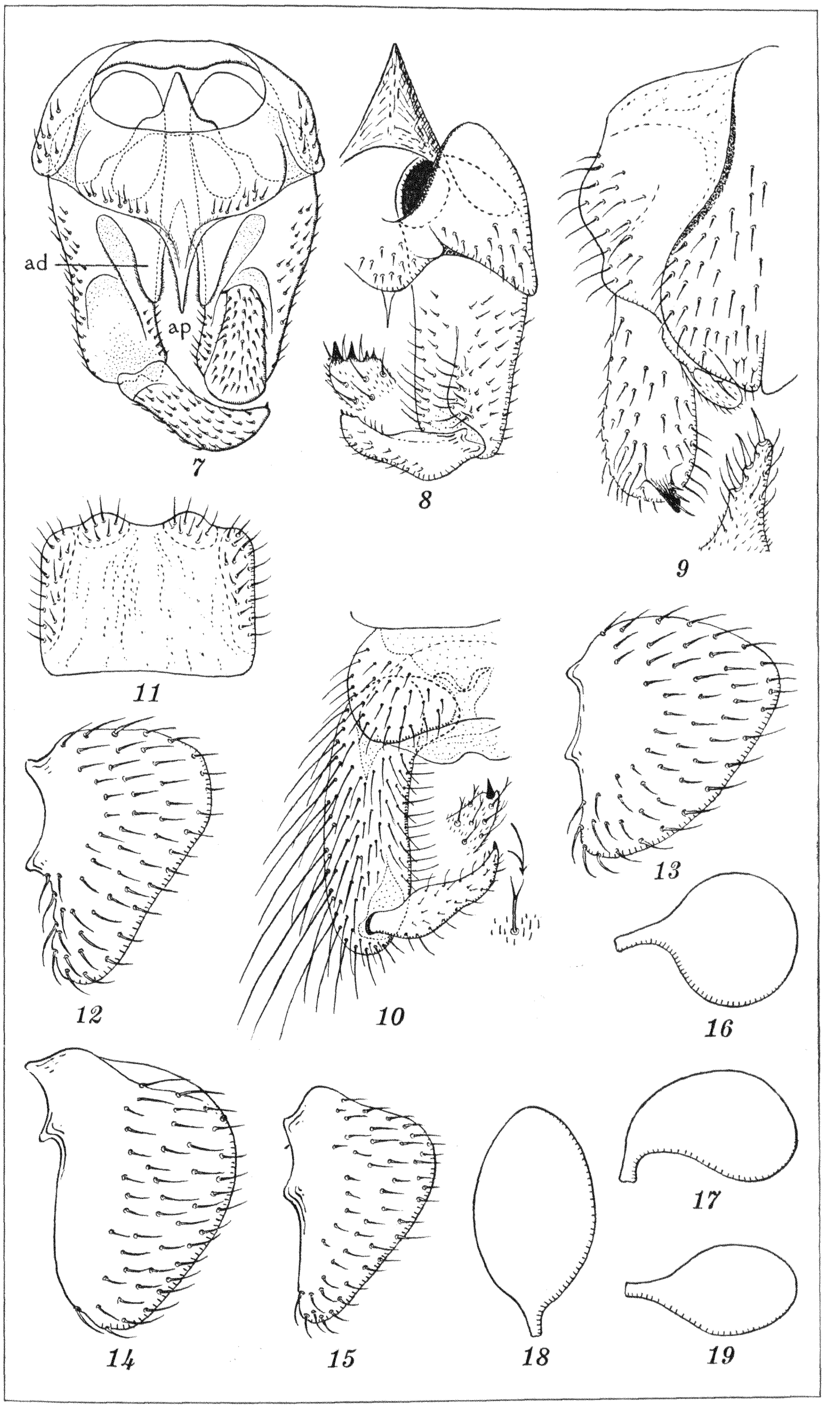


PLATE 2.

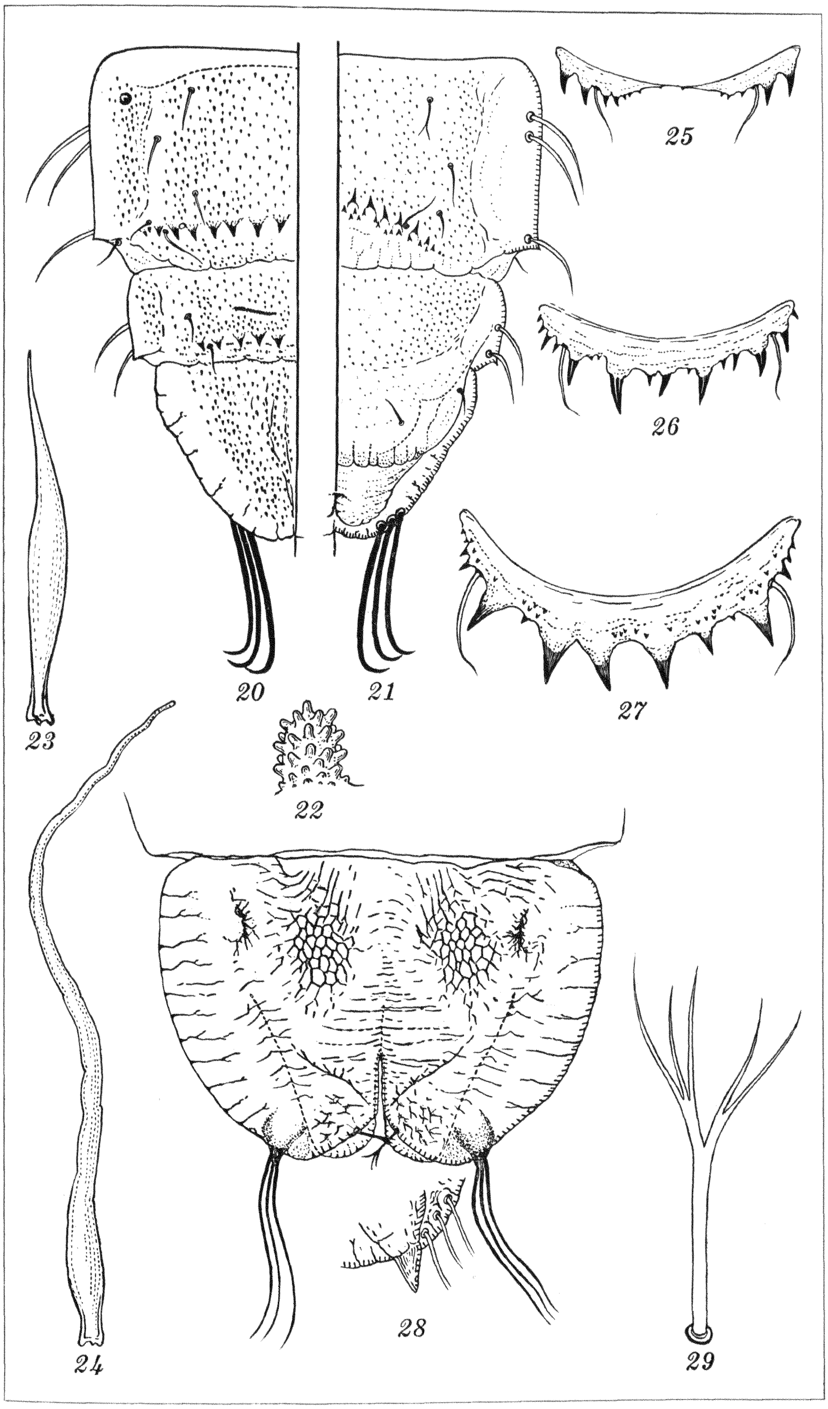
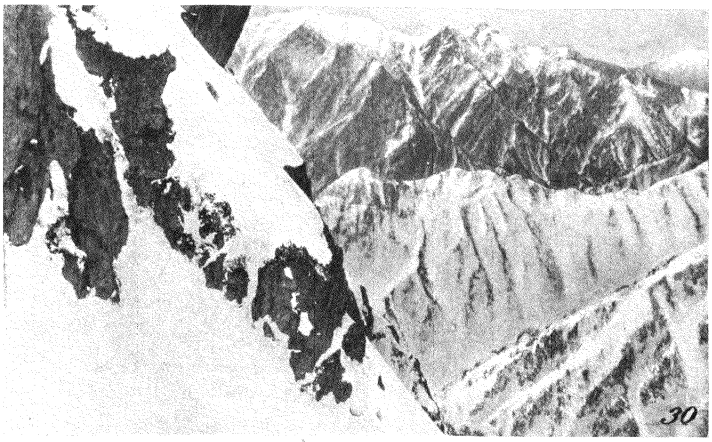


PLATE 3.



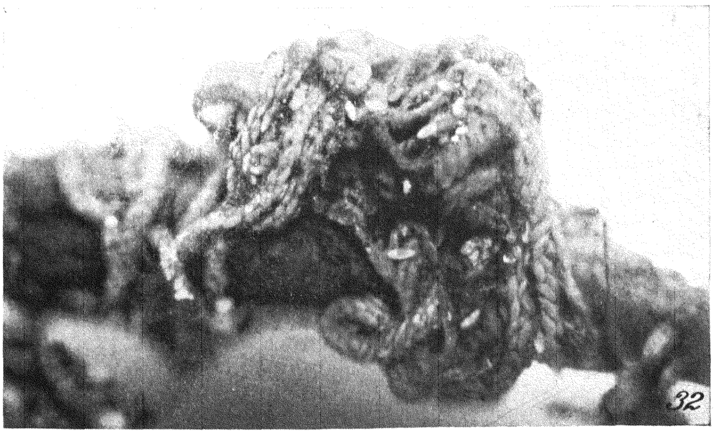


PLATE 4.

PHILIPPINE PSYCHODIDÆ (DIPTERA), I
PSYCHODINÆ [1]

By F. DEL ROSARIO

Of the National Museum Division, Bureau of Science, Manila

TWO PLATES AND FOUR TEXT FIGURES

The subfamily Psychodinæ comprises a group of nonblood-sucking moth flies belonging to the large family Psychodidæ. They are generally of small size, usually over 1 millimeter long, rarely attaining 3 millimeters. They can be distinguished from members of other subfamilies, especially Phlebotominæ, by the wings being folded rooflike over the abdomen, like tiny moths, and by the fact that the first forking of the second vein is near the base, instead of nearer the middle, of the wing.

The subfamily Psychodinæ, which contains at present a number of genera, is practically unknown in the Philippines. So far as I can ascertain, no species of this subfamily has hitherto been recorded from this country. While working the psychodid collection of the Bureau of Science, I discovered one specimen belonging to the genus *Psychoda*. This is evidently a distinct species and is apparently new to science. Two specimens collected by me at Baguio, Mountain Province, Luzon, may be treated here as two distinct species. From collections made in Alabang and San Pedro Makati, Rizal Province, and Manila, all in central Luzon, four species seem to be very distinct and are here described as new species.

The psychodid flies discussed, therefore, represent seven new species of the genus *Psychoda*. Three other species of the same genus are also included. The types of the new species described in this paper will be deposited in the Bureau of Science entomological collection.

Inasmuch as the literature dealing with the classification of the Psychodinæ shows some confusion in the status of certain genera, and since the morphology of the entire subfamily is at best but imperfectly known, I deemed it advisable to describe

[1] I am under obligation to Dr. L. B. Uichanco, professor and head of the Entomology Department, College of Agriculture, University of the Philippines, for reading the manuscript.

the external morphology of the adults of the genus *Psychoda*. These accounts are drawn from materials in the collection of the United States National Museum, from the Bureau of Science entomological collection, and from the author's personal collection, and summarize the important characters common to all the species I have examined.

PSYCHODIDÆ

PSYCHODINÆ

Genus PSYCHODA Latreille

Tipula, pt. LINNÆUS, Syst. Nat. (1859).
Psychoda LATREILLE, Precis d. caract. gen. d. Ins. (1796).
Trichoptera MEIGEN, Illiger's Mag. Ins. 2 (1803).

Very close to *Pericoma*, from which it may be distinguished by the rather elongate antennæ having fourteen to sixteen segments, the segments of the flagellum, except segment 13, possessing a basal spherical node and a long internode, the last three terminal segments of reduced size and may or may not be intimately united with each other.

Genotype.—Tipula phalænoides Linnæus.

EXTERNAL MORPHOLOGY

ADULTS

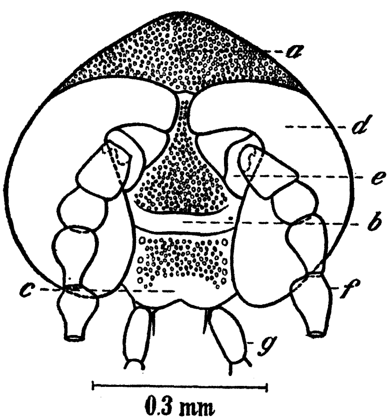


FIG. 1. *Psychoda albipunctata* Williston, female, head in cephalic aspect; *a*, occiput; *b*, frons; *c*, clypeus; *d*, compound eye; *e*, antennal fossa; *f*, antenna; *g*, maxillary palpus.

Occiput in both sexes usually covered with numerous, stout, forwardly projecting hairs. Eyes at frons separated by a distance varying from a fine line to about four times the diameter of one facet. Frons and clypeus together nearly triangular, with thick hairs (text fig. 1).

Proboscis about one-half as long as the head in both sexes. The mouth parts of the male are shown in text fig. 2. Tip of labium, or paraglossæ, may or may not be definitely enlarged with from four to six long or short teeth at the tip and with two to six long spines on the outer surface; those with enlarged lobe may not have any spine-

like teeth on its inner surface or may have as many as eight; the outer margin with four to twenty or more long and short spines. The remaining mouth parts are slightly chitinized and distally bear long and several short fine hairs. The labrum is unarmed and distally narrows to an almost acute apex bearing minute hairs. Mandible wanting. Hypopharynx well developed, strongly chitinized; distally narrowing to a pointed apex, bearing minute hairs. Maxillæ represented by a free, rodlike structure, the stipite, which is close to the hypopharynx and almost touching the anterior arm of the tentorium, and a feathery galea, which is nearly as long as the stipite. Cardines apparently wanting. Palpi in both sexes composed of four segments, the first segment generally the shortest. Sometimes the first three basal segments are of unequal length and the fourth only slightly longer. In some species the third is notably longer than the second. As a general rule, the terminal segment tapers and ends in a bluntly rounded apex bearing three to five or more long spines. In certain species the first and third segments are expanded near the middle or anteriorly and contain a deep pit or sensory cup; the inner surface of this pit bears a number of minute modified hairs shaped like a drum-stick.

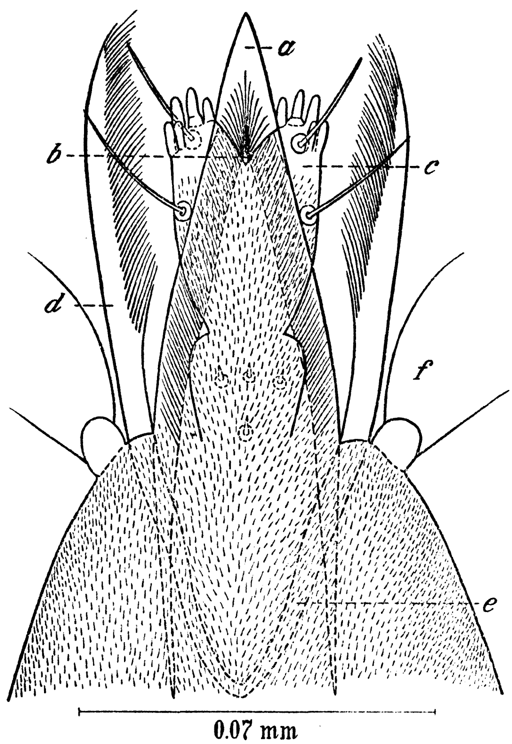


FIG. 2. *Psychoda makati* sp. nov., mouth parts, dorsal aspect; *a*, labrum; *b*, hypopharynx; *c*, labium; *d*, galea; *e*, stipite; *f*, palpus.

Antennæ composed of fourteen to sixteen segments, all the segments distinctly separated from each other. Segment 1 subcylindrical, longer than broad, with stout hairlike spines. Seg-

ment 2 (torus) globular, also provided with stout spinelike hairs arising at about the middle region of the node. Segments of the flagellum, excepting segment 13, with a basal spherical node and with a neck or internode which is usually as long as the node, often longer and sometimes shorter, especially in the female. Segment 13 generally without an internode but sometimes with a very short elongation of a rather insignificant length. The segments following segment 13 are quite diminutive and may be distinctly separated from each other or they may be partly or completely united. Hairs on these segments spinelike. Each segment of the flagellum, except the last three terminal, bears a whorl of five or six verticils of bristlelike hairs, usually recurved and pointing toward the node of each succeeding segment. Long and short sensory spines, or "ascoids," on segments 3 to 13; they are always two to the segment and are diametrically opposed in their point of insertion in the node. These sensory spines are of various shapes (text fig. 3), the usual form being a 3-branched spine, the two anterior branches projecting towards the internode and a posterior branch towards the node. In the female antennæ of *Ps. nigra* and *Ps. autumnalis* each sensory spine of the node is composed of five or more

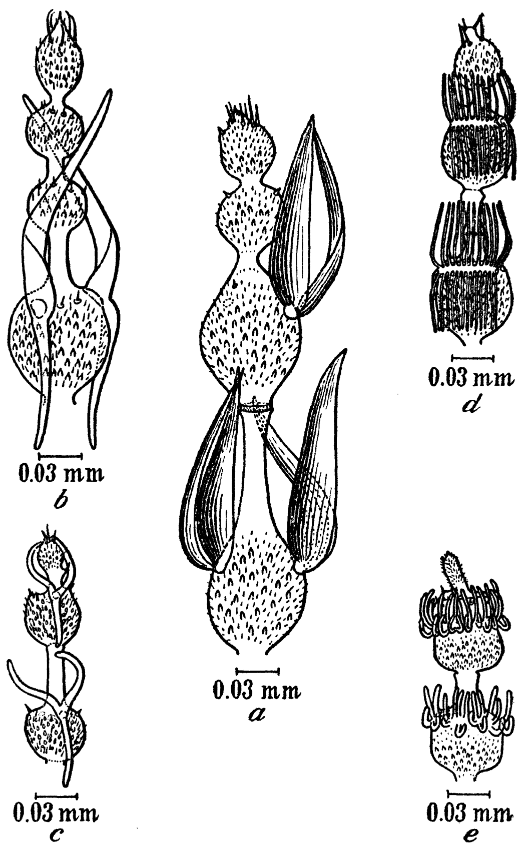


FIG. 3. ***Psychoda,*** **five species, showing sensory spines at tip of antennæ of males;** ***a, Ps. olympia*** **Kincaid;** ***b, Ps. bicolor*** **Banks;** ***c, Ps. severini*** **Tonnoir.** ***d, Ps. snowhilli*** **del Rosario;** ***e, Ps. nigra*** **Banks.**

fingerlike branches; these sensory spines do not surround the node as found in the male antennæ of the same species.

Thorax strongly arched and very slightly projecting over the head. Dorsum clothed with both short and long erect hairs. Scutellum thickly set with long straight hairs, which are grayish or whitish in many species, some with short hairs. Pleura usually fuscous brown or pale brown, in some species with short hairs.

Wings usually ovate or lanceolate, in many species gray with darker areas along the anterior margin or fringe. They are usually twice as long as wide, although in the male of some species the wings are a little less than twice as long as wide. Surface of the wings entirely covered with upright hairs, which may be either gray or white or both, longer recumbent hairs also present, especially along the anterior and posterior margin. Wings may show a mottled appearance as a result of the alternate black and white patches of erect hairs on the upper surface. In one species, *Ps. autumnalis,* a denuded wing is conspicuous for the presence of clear pigmented areas on the veins, which give the wing a distinctly mottled appearance. Venation as shown in Plate 1. Sc either short or long, the usual length being nearly that of the horn or semichitinous pad above it at the base of the anterior margin of the wing, apparently not ending at C. Fork R_2R_3 in most species before the level of fork M_1M_2, with four exceptions, or slightly behind in two species. In *Ps. nigra, superba, superba* var. *conspicua,* and *snowhilli* fork R_2R_3 is distinctly on the level with fork M_1M_2, while in *Ps. autumnalis* and *Ps. quadripunctata* fork R_2R_3 is found notably behind the level of fork M_1M_2. Bifurcation of R_2 and R_3 and M_1 and M_2 not always complete, as the origin of R_3 or M_2 is sometimes loose. This condition may be seen in *Ps. pusilla, uniformis,* and *tridactila* and in *bicolor* (only that of fork M_1M_2).

Legs generally pale brown, often with dark gray hairs. Femora of forelegs strongly developed, sides in posterior view with some rows of bristles; pile on the outer surface usually gray, in some species, as in *Ps. autumnalis,* with scattered whitish hairs on the basal half of the anterior surface; apically with a narrow white band. Fore tibiæ generally pale brown, often fuscous, seldom with white band, except in *autumnalis.* First tarsal segment the longest, almost twice as long as the second, second to fourth tarsal segments decreasing in length progressively, fifth segment being as long as second or slightly

longer. Bristles on apical end of first four tarsal segments of all legs spinelike. Claws of all legs equal.

Abdomen composed of nine segments, dorsum pale brown or brown, lateral margins usually lighter. Each abdominal segment thickly clothed dorsally with a ringlike series of erect, mingled, white and gray hairs. Abdomen of male appears to be slenderer than that of female; hypopygium very conspicuous.

Hypopygium of male (text fig. 4) very prominent and easily distinguishable by the presence of relatively large inferior appendages. Like those of the Culicidæ, hypopygium inverted after hatching so that ninth tergite is usually longer than the eighth; sternite narrowed to a small chitinized strip, which is somewhat arched, tergite extending posteriorly, slightly arched to fit the elongated inferior appendages. The whole segment well clothed dorsally with strong hairs, most thickly set on distal half and at its posterior margin. Anus at posterior end of ninth segment; anal flap, which is well covered with short, fine hairs, appearing to be intimately connected with anus. Inferior appendages well developed, generally longer than ninth segment, often slender, curving ventrally, swollen slightly near the base, and gradually tapering toward an acute point in many species; terminal spinules clavate, frequently less than basal portion of the segment, number varying from 1 to 15; clothed at its base with longer and shorter hairs intermixed with a few minute hairs. Superior appendages of two segments the length of which varies according to species; basal segment large, swollen near the base; proximal segment about as long as the basal, slender, tapering to an acute point, with short and weak spines above and below. Ædeagus varying in shape and size in different species, well chitinized and composed of from one to five parts, usually two.

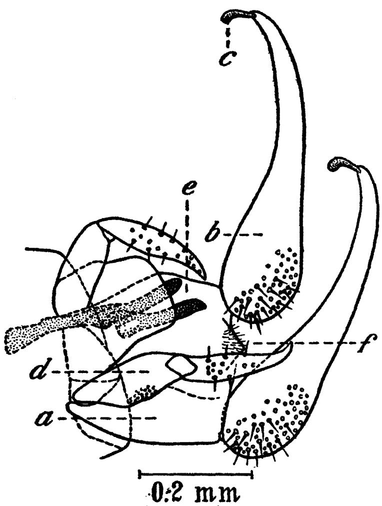


FIG. 4. *Psychoda alternata* Say, male hypopygium, dorsal view; *a*, ninth tergite; *b*, inferior appendage; *c*, terminal spinule; *d*, superior appendage; *e*, ædeagus; *f*, anal flap.

Ventral plate of female in many species terminating posteriorly in two finely pubescent lobes with a slight emargination between; densely clothed with black or gray hairs, depending on the species. Ovipositor consisting of two bladelike pieces, closely applied, about twice as wide as ventral plate, pointed, inner surface provided with a single row of short, hairlike spines.

PSYCHODA ALTERNATA Say.

Psychoda alternata SAY, Long's Exp. St. Peter's River App. (1823) 358.

In view of the detailed descriptions given in a previous article,[2] only the following characters need be noted.

The wings with a mottled appearance. Tips of several veins of wing with small patches of black or dark brown hairs. Outer surface of tip of labium with three labial spines. Antennæ of fifteen segments, the sensory spines on the node with two, well-developed, anterior branches and one posterior branch. Ædeagus consisting of two unequal parts; one shorter piece with an evenly pointed tip intimately attached to the latter.

Male.—Length of body, 1.5 millimeters; wing, 1.71; antenna, 1.32; width of head, 0.57; wing, 0.73.

Apparently a cosmopolitan species. It occurs throughout the United States, where it is most commonly found breeding on the bacterial film of the sprinkling filter beds used in the purification of sewage.

This is the first record of this species in the Philippine Islands. Several specimens, both males and females, were caught in a ditch along side of the street.

LUZON, Manila, July, 1935 (*G. Bellosillo*); *19355*, Bureau of Science entomological collection.

PSYCHODA ALBIPUNCTATA Williston.

Psychoda albipunctata WILLISTON, Ent. News **55** (1893) 113.

A revised description of this species has been given in a former paper (del Rosario, 1935) and need not be repeated here.

Male.—Length of body, 2.23 millimeters; wing, 2.60; antenna, 0.13; width of head, 0.7; wing, 1.28.

Like *Ps. alternata* this species is very wide-spread, but hitherto not recorded from the Philippines. Several specimens of all stages were collected by the author on standing water in

[2] Del Rosario, F., Philip. Journ. Sci. **59** (1936) 85–148.

the basement of the Bureau of Science building. They were breeding together with *Culex quinquefasciatus.*

LUZON, Manila, February, 1935 (*F. del Rosario*) ; *18863,* Bureau of Science entomological collection.

PSYCHODA PHALÆNOIDES (Linnæus, 1758).

Psychoda phalænoides (Linnæus, 1758) TONNOIR, Ann. Soc. Ent. Belgique 62 (1922) 67–68.

Male.—Length of body, 1.61 millimeters; wing, 1.59; antenna, 0.97; width of head, 0.35; wing, 0.63.

The specimens examined were collected from banana stalks together with *Ps. musæ* sp. nov. and *Ps. alabangensis* sp. nov. In America and Europe *Ps. phalænoides* has been reported breeding on the sprinkling filter beds of sewage plants together with *Ps. alternata.*

LUZON, Rizal Province, Alabang, July 10, 1935 (*F. del Rosario*), 7 males and 1 female; *19357,* Bureau of Science entomological collection.

PSYCHODA BAGUIOENSIS sp. nov. Plate 1, figs. 1 to 4.

Male.—Occiput black, borders lighter, covered with long, straight, yellowish hairs. Eyes confluent at frons. Frons and clypeus together triangular, dark brown, with yellowish hairs directed towards the proboscis, hairs at center of triangle thickly set and stout. Proboscis short, about as long as the second palpal segment, clothed with yellowish hairs. Tip of labium, or paraglossæ, expanded into a bulblike structure, each lobe possessing one short tooth on inner surface; outer surface of the lobe with about seven long spines and covered with fine, minute microtrichia. Palpi with yellowish hairs, slightly longer than width of the head; segment 1 shortest; segment 3 about as long as 2 or 4, but wider than any of the three segments; palpal segments in the proportion of 4 : 5 : 6 : 7. Nodes of antennæ black; hairs grayish except for the two segments before the last two, which are grayish white; 16-segmented; segment 1 small, about as long as wide; 2 a little smaller than 1 but wider than long; 3 to 12 flask-shaped, basal nodes about the same length as adjacent slender internode, over twice as wide as diameter of internodes; 13 like 12 but without any definite internode; 14, 15, and 16 small, of about the same size, somewhat ovoid, distinctly separated from each other by a very short neck; 16 bearing a short stout spine at apex. Sensory spines on segments 3 to 13 similar to those of *Ps. olympia* in shape and structure, but

differing in having only one spine on each side of the node. *Psychoda olympia* has two leaflike sensory spines on each side of the node.

Dorsum of thorax black with grayish white hairs on anterior margin; four batches of erect black hairs arranged in a band on posterior margin a little above costa near attachment of wing; an area clothed with silvery white hairs immediately behind. Sides of thorax brown, apparently bare. Wings somewhat ovate, over twice as long as wide, dark gray, with brownish tints; small white patches at tips of all longitudinal veins, starting tip of R_1; on R_1, beside the small white patch at its tip are two black spots, the one nearer the base of the wing composed of erect black hairs, minute white spots forming a whitish band running from tip of R_2 across to tip of M_3. Sc ending on level of origin of R_1. Origin of R_2R_3 on R_4 before level of r-m, fork R_2R_3 beyond middle of wing. Fork M_1M_2 closer to fork R_2R_3 than to r-m. Cell C and Sc darker and highly pigmented. Knob of halteres gray, stem yellowish. Legs black with grayish hairs. Tibiæ of all legs with several long erect hairs, which appear white under reflected light.

Abdomen dark brown dorsally, blackish beneath, the incisures pale brown to bronze; dorsum wholly covered with long dark gray hairs; base of venter with grayish brown hairs, toward tip with dark gray hairs; lateral margin either with pure dark gray or a mixture of dark gray and grayish brown hairs. Hypopygium concolorous with dorsum of abdomen, with uniformly dark gray hairs. Ninth tergite about as long as wide. Inferior appendages similar to those of *Ps. helicis*, stout, about as long as ninth tergite; entire surface covered with long and short spines; apex bearing two long spinules over half the length of the appendages. Basal segment of superior appendages broad, strongly developed; inner margin with one long spine; second segment clawlike, apex bearing a single, terminal, hairlike spine. Ædeagus consisting of three pointed parts, the median piece longest, the two side pieces strongly opposed against each other.

Length of body, 1.2 millimeters; wing, 1.31; antenna, 1.25; width of head, 0.34; wing, 0.56.

LUZON, Mountain Province, Baguio, February 10, 1935 (*F. del Rosario*), 1 specimen, male; *19357*, Bureau of Science entomological collection.

This species is distinguished by the antennæ, which have grayish white hairs on the two segments before the last two,

by the peculiar shape of the sensory spines, by the mottled appearance of the wings, by the black band on the dorsum of the thorax, and the form of the hypopygial appendages.

PSYCHODA ZIGZAGENSIS sp. nov. Plate 1, figs. 5 to 7.

Female.—Occiput black, clothed with dark gray hairs. Eyes at frons separated by a distance equal to a little over diameter of one facet. Frons and clypeus together triangular, black, covered with thick brushlike hairs, which are more or less recumbent. Proboscis golden with grayish hairs, over one and one-half times as long as first palpal segment. Tip of labium with three long teeth and one short tooth on each side of the lobe; outer surface with one, long, labial spine. Palpi dark gray, covered with grayish pruinescence; longer than width of the head; palpal segments nearly of equal length, apical segment bearing two spinelike hairs at tip; proportion of palpal segments 5 : 4 : 4 : 5. Nodes of antennæ dark gray; hairs grayish; 16-segmented; segment 1 the longest, much longer than wide; 2 globular; 3 to 13 flask-shaped, node of each segment nearly three times diameter of internode; 13 without internode and intimately connected with the three terminal segments, which are ovoid; 16 smallest. Sensory spines on segments 3 to 13 of the usual type, having two slender anterior branches and one posterior branch.

Dorsum of thorax pale yellow with erect yellowish hairs; pleura pale yellow with a few, scattered, yellowish hairs. Wings lanceolate, over twice as long as wide; pale yellow with yellowish hairs all over the veins; fringes slightly smoky. Sc about one and one-half times as long as the semichitinous pad above it, ending at about the same level as the origin of R_1. Origin of R_2R_3 on R_4 distinctly before the level of r-m, the fork at about the middle of wing. Fork M_1M_2 closer to fork R_2R_3 than to r-m. Halteres gray with yellowish hairs. Femora of forelegs dull brown with gray hairs; tibiæ and tarsal segments covered with black hairs, except claws, which are surrounded by a few, short, whitish hairs. Femora of middle and hind legs light brown, with light gray hairs; tibiæ and tarsi slightly darker under reflected light.

Abdomen dull brown, thickly clothed with yellowish hairs; genitalia covered with bristlelike yellowish to golden hairs. Ventral plate about twice as long as broad; posterior lobes distinctly separated by a deep notch; outer surface of lobes with

long bristles. Ovipositor about three times the width of the ventral plate, distinctly curved and pointed.

Length of body, 1.25 millimeters; wing, 1.34; antenna, 0.72; width of head, 0.34; wing, 0.51.

LUZON, Mountain Province, Baguio, February 10, 1935 (*F. del Rosario*) ; *19358*, Bureau of Science entomological collection.

This species may be distinguished from all other known forms by the single labial spine at the tip of the labium. It is the only one I have seen possessing this character, and none of the others have the tibiæ and tarsal segments of the forelegs wholly black.

PSYCHODA BANKSI sp. nov. Plate 1, figs. 8 to 12.

Male.—Occiput grayish brown with whitish hairs. Eyes at frons separated by a fine line. Frons slightly arched, light brown, covered with thick, recumbent, grayish hairs. Clypeus rather broad, less hairy than frons, hairs light brown. Proboscis short, light brown, yellowish pruinose. Tip of labium not well expanded into a bulblike structure, each lobe with two, rather long, slender teeth at margin and two short teeth on inner surface just below the two long teeth; outer surface with one short and two long labial spines; entire surface of labium covered with very short microtrichia. Palpi yellowish with gray hairs, about twice as long as proboscis; fourth segment longest, with three spines at extreme end; palpal segments in the proportion of 5 : 5 : 5 : 4. Antennæ grayish brown, verticils of hairs yellowish white; 16-segmented; segment 1 broad at apical portion, slightly longer than 2, which is globular; 3 to 13 flask-shaped, the diameter of node over twice that of internode; 14 to 16 separated by a short neck, 14 and 15 each with a toothlike projection bearing a small spine at its apical end, segment 16 ovoid with several spinelike hairs at apex. Sensory spines apparently wanting.

Dorsum of thorax light brown, covered with light yellowish gray hairs. Pleura pale brown, apparently without hairs. Wings smoky, with gray hairs, apparently without spots; length over twice greatest width. Base of costa decidedly enlarged. Sc ending at about level of origin of R_1. Fork R_2R_3 at about middle of wing; origin of forking R_2R_3 at the same level with r-m. Fork M_2M_3 much closer to fork R_2R_3 than to r-m. Halteres grayish brown, with short yellowish hairs. Femora of all legs pale brown with yellowish gray hairs; tibiæ and tarsi pale

brown but with yellowish gray hairs. Abdomen entirely pale yellow, covered with thick yellowish gray hairs, especially on the dorsum and hypopygium. Ninth tergite about as long as wide; posterior portion broad. Inferior appendages slender, not well developed basally, but with hairlike spines on their outer surfaces; about twice length of ninth tergite; apically bearing a single spinule which is about one-third length of appendages. Superior appendages 2-segmented; basal segment broad, shorter than the apical, which tapers gradually into an almost pointed end; whole surface of apical segment bearing a few scattered hairlike spines. Ædeagus composed of a single rodlike piece, which splits into halves at about two-thirds its length; each piece supported by a small, triangular, chitinized piece.

Length of body, 1.01 millimeters; wing, 1.09; antenna, 1.17; width of head, 0.44; wing, 0.62.

Female.—Slightly lighter than the male. In venation, markings, and structure of the antennæ like the male. Ventral plate much wider than long, with two distinct lobes posteriorly, bearing long spines and microtrichia. Ovipositor broad basally, tapering gradually to a sharp apex; apical half with several scattered spines.

Length of body, 1.53 millimeters; wing, 1.79; antenna, 1.04; width of head, 0.47; wing, 0.78.

LUZON, Laguna Province, Mount Maquiling, February 23, 1908, reared from wild figs in the forest (*C. S. Banks*); 4 males and 7 females; *8621*, Bureau of Science entomological collection.

PSYCHODA MUSÆ sp. nov. Plate 1, figs. 13 to 16.

Male.—Occiput brown, narrowed medially, covered with erect, grayish white hairs, anterior margin with a single row of from 8 to 10, long, spinelike hairs. Eyes at frons nearly touching each other. Frons and clypeus together not triangular in outline, thickly covered with bushlike grayish white hairs. Clypeus brown, not convex medially, wider than long, whole surface with somewhat recumbent, grayish white hairs. Proboscis brown, reaching to about the middle of the second palpal segment. Tip of labium of medium size, provided with three long teeth and one short tooth; membranous area with two unequal labial spines. Palpi and antennæ of same coloration as clypeus; segments of palpi in the proportion of 13 : 15 : 15 : 20. Antennæ 14-segmented, with whorls of grayish white hairs lying closely to the segments, thus giving it a solid appearance as seen in

Ps. phalænoides; basal segment rather tubular, width less than greatest width of segment 2; which is somewhat spherical, distinctly larger than the other segments; 3 club-shaped, node about as long as its internode; 4 to 12 nearly flask-shaped; 13 slightly constricted at approximately anterior two-thirds, with one small toothlike projection bearing a minute spine; 14 small, ovoid. Sensory spines on segments 3 to 12 with two long anterior branches, one curved basally, at a right angle to the other branch; a slender posterior branch extending a little over the length of its node.

Dorsum of thorax dull brown to bronze; surfaces covered with long whitish hairs. Scutellum somewhat pale brown but with the same coating of hairs as on dorsum of thorax. Pleura pale yellowish brown. Wings over twice as long as broad, slightly angulated at tip. Vestiture of wings smoky. Anterior fringe slightly darker towards base. Sc not well developed; a little over length of the heavily pigmented, semichitinous pad above it. Origin of R_2R_3 distinctly before level of r-m. Fork R_2R_3 before the middle of the wing. Fork M_1M_2 before middle of the wing, closer to fork R_2R_3 than to r-m. Halteres yellowish. All coxæ and trochanters pale brown; femora and tibiæ somewhat darker, with grayish hairs on anterior surface, appearing whitish under reflected light; posterior surface with short and almost white hairs. Anterior surfaces of tarsal segments with dark gray hairs; under reflected light the scalelike hairs appear whitish when seen from above.

Abdomen pale brown dorsally; sides yellowish; venter and hypopygium slightly darker; covering of hairs gray, heavy towards posterior end. Ninth tergite slightly longer than broad, slightly swollen posteriorly. Inferior appendages slender, rather tubular, very slightly swollen basally; terminal spinule short, about one-seventh length of inferior appendages. Basal segment of superior appendages not well developed; distal segment slender, clawlike, with sharp apex, whole surface covered with numerous spinelike hairs. Ædeagus composed of three pieces, a median, broad, somewhat tubular piece with rounded apex and two pointed side pieces, shorter and slenderer than the median, and strongly curved inwardly at their apices.

Length of body, 1 millimeter; wing, 1.09; antenna, 0.73; width of head, 0.27; wing, 0.42.

LUZON, Rizal Province, Alabang, July 10, 1935 (*F. del Rosario*) ; *19359,* Bureau of Science entomological collection.

This species was collected together with *Ps. phalænoides* and *Ps. alabangensis* from banana stalks at about 0.5 to 1 meter above the ground.

PSYCHODA ALABANGENSIS sp. nov. Plate 1, figs. 17 to 20.

Male.—Occiput light brown, not broad, with gray hairs; a row of five stout hairs on anterior margin. Eyes separated at frons by a distance equal to diameter of one facet. Frontal triangle dull brown, clothed with yellowish gray hairs, these hairs confined to a rectangular area between antennal fossæ. Clypeus dull brown, slightly longer than broad, with long grayish hairs directed toward proboscis. Proboscis brown, with whitish pubescence. Tip of labium provided with three long teeth and two long labial spines. Palpi grayish brown with gray hairs; proportion of palpal segments 15 : 16 : 15 : 19. Antennæ 15-segmented; grayish brown, nodes with long gray hairs distinctly spreading outward; segment 1 slightly longer than 2, which is spherical; 3 to 12 flask-shaped, internode longer than node, except in the first two basal segments; 13 globular, with a neck; 14 smaller than 13 and intimately joined to 13 and 15; segment 15 slightly smaller than 14, ovoid. Sensory spines composed of two, long, anterior branches and one, short, posterior branch.

Dorsum of thorax light brown with erect gray hairs. Wings lanceolate, vestiture gray. Fringes smoky. Sc ending on the same level as origin of R_1. Fork R_2R_3 at about middle of wing; fork M_1M_2 closer to fork R_2R_3 than to r-m. Coxæ, tibiæ, and tarsi of all legs pale brown, with grayish hairs, those on tarsal segments appearing whitish under reflected light.

Abdomen yellowish brown, thickly clothed with hairs similar to those on thorax. Hypopygium pale brown, with gray hairs. Ninth tergite wider than broad, sides swollen; anal flap prominent, covered with short fine hairs and microtrichia. Inferior appendages well developed basally, slightly tapering distally; terminal spinule about one-sixth length of appendages. Basal segment of superior appendages broad and stout, with thick hairs on outer margin; apical segment longer than basal segment, gently curved, tapering to an almost pointed apex and bearing several spinelike hairs. Ædeagus consisting of one rather tubular piece, nearly S-shaped at distal end, posteriorly dividing into two pieces for a short distance, these pieces uniting again posteriorly to form a slender, somewhat pointed piece.

Length of body, 1.11 millimeters; wing, 1.17; antenna, 0.6; width of head, 0.28; wing, 0.34.

LUZON, Rizal Province, Alabang, July 10, 1935 (*F. del Rosario*) ; *19360*, Bureau of Science entomological collection.

PSYCHODA MANILENSIS sp. nov. Plate 1, figs. 21 to 24.

Female.—Occiput and frontal triangle light brown covered with yellowish hairs. Eyes separated at frons by a distance equal to about four times diameter of one facet. Clypeus pale brown, twice as wide as long, slightly convex, with long grayish hairs. Proboscis brown, bulblike, a little longer than first palpal segment. Paraglossæ with six short teeth on each side of lobe and over twenty long stout spines. Theca heavily chitinized, stem about one-third length of anterior arms. Palpi dark brown, with grayish pubescence, first segment shortest; proportion of segments 2 : 7 : 7 : 9. Antennæ 16-segmented, pale yellow, with long whitish hairs which tend to spread outward; segment 1 stout, slightly longer than 2, which is globular; 3 smaller than 2, with a short neck; 4 to 15 more or less club-shaped, node of each segment longer than internode; 16 elongated and terminating in a spike, with fine microtrichia. Sensory spine composed of one long anterior branch, one on each side of node.

Dorsum of thorax light brown, with long, erect, yellowish white hairs, their tips almost white. Pleura pale brown, without hairs. Wings ovate, somewhat angulated at tip, less than twice as long as wide, large yellowish spot at base of costa close to semichitinous pad, another large yellowish spot at tip of wing extending from tip of R_3 to M_2, entire wing brownish black with distinct black patches at tips of veins R_2, R_3, R_4, R_5, M_1, M_2, and M_3. Sc long, ending at about the same level as origin of R_2R_3. Fork R_2R_3 before level of fork M_1M_2 and before middle of wing. Fork M_1M_2 about as close to r-m as to fork R_2R_3. Knob of halteres yellowish. All femora pale brown, with brownish black hairs mixed with yellowish white hairs. Tibiæ and tarsal segments with brownish black hairs, but distinctly annulated with yellowish white bands.

Abdomen wholly brown, covered with yellowish hairs; incisure lighter. Ventral plate reddish brown, deeply emarginated posteriorly into two rather pronounced lobes. Ovipositor broad at the base, not pointed at apex.

Length of body, 1.5 millimeters; wing, 1.79; antenna, 1.09; width of head, 0.6; wing, 0.96.

LUZON, Manila, June, 1935 (*F. del Rosario*) ; *19361*, Bureau of Science entomological collection.

PSYCHODA MAKATI sp. nov. Plate 1, figs. 25 to 29.

Male.—Occiput brown, narrowed at sides, clothed with gray hairs. Eyes separated at frons by a distance equal to diameter of one facet. Frons and clypeus together not triangular in outline, covered with gray hairs. Clypeus brown, slightly convex medially, much wider than long, entire surface covered with distinctly gray recumbent hairs. Proboscis brown, longer than first palpal segment. Tip of labium with four fairly long teeth, nearly equal in length; outer surface of membranous area with two, slender, labial spines of about the same length. Palpi and antennæ similar in color to clypeus; proportion of palpal segments 10 : 10 : 11 : 14. Antennæ of sixteen segments; segment 1 of about the same size as 2, which is nearly globular; 3 to 12 flask-shaped, diameter of the node over twice that of its corresponding internode; 13 much broader than 14, but the two segments intimately united with each other; 15 smaller than 14; 16 nearly pear-shaped, separated from 15 by a very short neck. Sensory spines on segments 3 to 13 consisting of two anterior branches and one posterior branch.

Dorsum of thorax light brown, covered with thick-set grayish hairs. Pleura pale brown with a few short, scattered, whitish hairs. Wings over twice as long as broad, covering of hairs smoky. Anterior and posterior fringes slightly darker than other hairs of wing. Sc slightly longer than semichitinous pad above it. Origin of R_2R_3 distinctly before the level of r-m. Fork R_2R_3 and fork M_1M_2 very loosely chitinized. Halteres pale yellow. Coxæ and trochanter of all legs light brown; all femora and tibiæ brown, covering of hairs gray. Tarsal segments with gray hairs appearing yellowish white under reflected light.

Abdomen brown, incisures pale brown. Hypopygium dark brown, covered with thick-set hairs. Ninth tergite wider than broad, slightly swollen medially. Inferior appendages slender, about one and a half times length of ninth tergite; terminal spinule short, wider at tip. Basal segment of superior appendages strongly developed; distal segment well developed, inner margin with a single row of thirteen to fifteen spines. Ædeagus composed of three pieces; a median broad piece slightly curved with rounded apex and two, slender, sharply pointed, side pieces, strongly curved near their apices.

Length of body, 0.94 millimeter; wing, 1; antenna, 0.7; width of head, 0.26; wing, 0.48.

LUZON, Rizal Province, San Pedro Makati, July 4, 1935 (*F. del Rosario*); 1 male and 1 female, attracted to light; *19362*, Bureau of Science entomological collection.

Female.—Resembling male. Occiput much broader than that of male. Eyes more widely separated at frons than those of male. Teeth at tip of labium more prominent. Tip of antenna similar to that of male. Ventral plate narrow near base, widening posteriorly into equal lobes, which are separated by a deep emargination. Ovipositor brown, slightly curved and pointed.

Length of body, 1 millimeter; wing, 1.09; antenna, 0.73; width of head, 0.29; wing, 0.51.

ILLUSTRATIONS

[Drawings inked by Messrs. V. V. Marasigan, J. Trinidad, H. T. Costelo, and R. C. Aguilar and Miss R. R. Ico, of the National Museum Division.]

PLATE 1

FIGS. 1 to 4. *Psychoda baguioensis* sp. nov.; *1*, venation; *2*, male hypopygium; *3*, tip of labium; *4*, tip of antenna, male.

5 to 7. *Psychoda zigzagensis* sp. nov.; *5*, venation; *6*, ventral plate; *7*, tip of labium.

8 to 12. *Psychoda banksi* sp. nov.; *8*, venation; *9*, ventral plate; *10*, tip of antenna, male; *11*, tip of labium; *12*, male hypopygium.

13 to 16. *Psychoda musæ* sp. nov.; *13*, venation; *14*, tip of antenna, male; *15*, tip of labium; *16*, male hypopygium.

PLATE 2

FIGS. 17 to 20. *Psychoda alabangensis* sp. nov.; *17*, venation; *18*, tip of labium; *19*, tip of antenna, male; *20*, male hypopygium.

21 to 24. *Psychoda manilensis* sp. nov.; *21*, venation; *22*, ventral plate; *23*, tip of antenna, female; *24*, tip of labium.

25 to 29. *Psychoda makati* sp. nov.; *25*, venation; *26*, tip of antenna, male; *27*, ventral plate; *28*, tip of labium; *29*, male hypopygium.

TEXT FIGURES

FIG. 1. *Psychoda albipunctata* Williston, female, head in cephalic aspect; *a*, occiput; *b*, frons; *c*, clypeus; *d*, compound eye; *e*, antennal fossa; *f*, antenna; *g*, maxillary palpus.

2. *Psychoda makati* sp. nov., mouth parts, dorsal aspect; *a*, labrum; *b*, hypopharynx; *c*, labium; *d*, galea; *e*, stipite; *f*, palpus.

3. *Psychoda*, five species, showing sensory spines at tip of antennæ of males; *a*, *Ps. olympia* Kincaid; *b*, *Ps. bicolor* Banks; *c*, *Ps. severini* Tonnoir; *d*, *Ps. snowhilli* del Rosario; *e*, *Ps. nigra* Banks.

4. *Psychoda alternata* Say, male hypopygium, dorsal aspect; *a*, ninth tergite; *b*, inferior appendage; *c*, terminal spinule; *d*, superior appendage; *e*, ædeagus; *f*, anal flap.

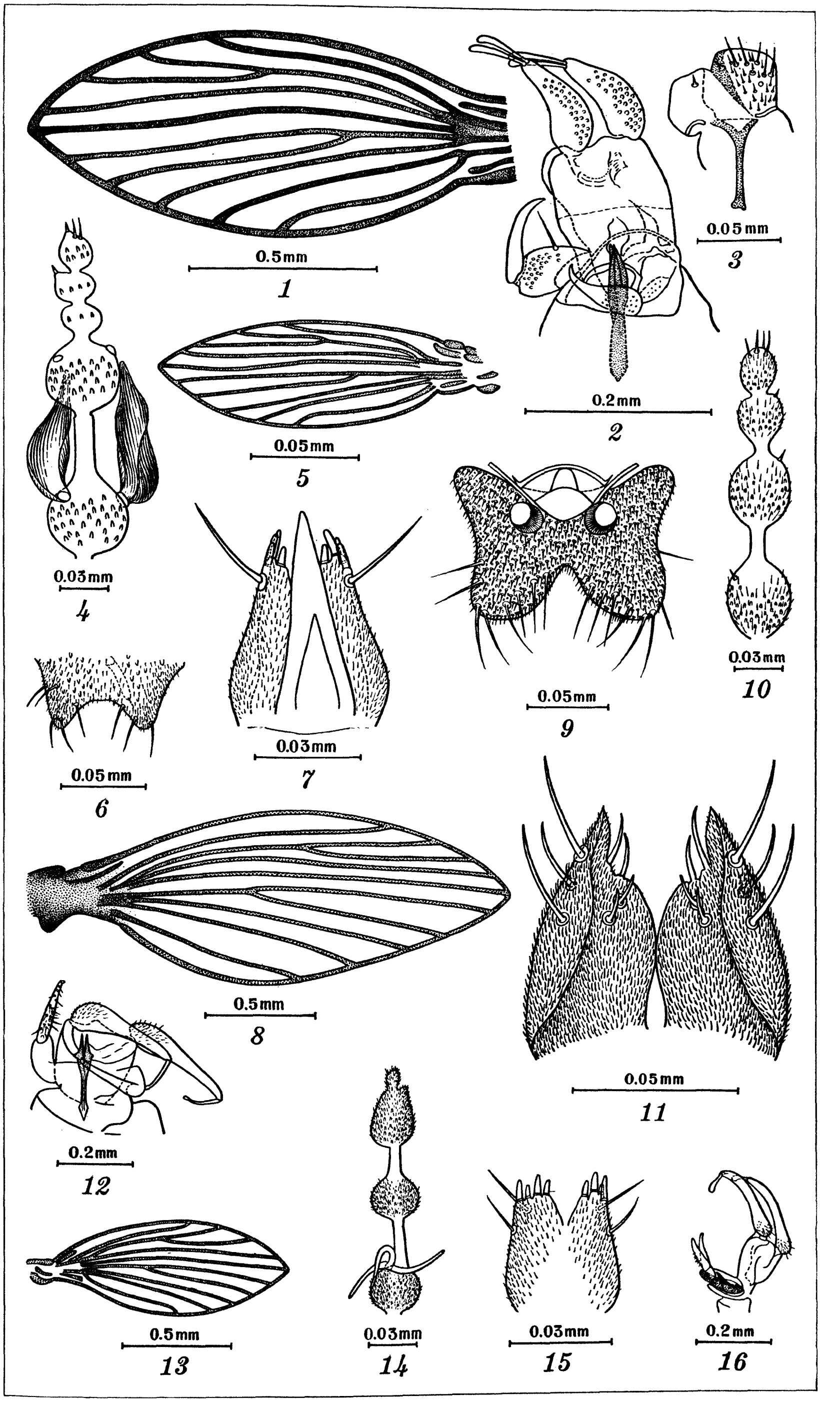

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PLATE 1.

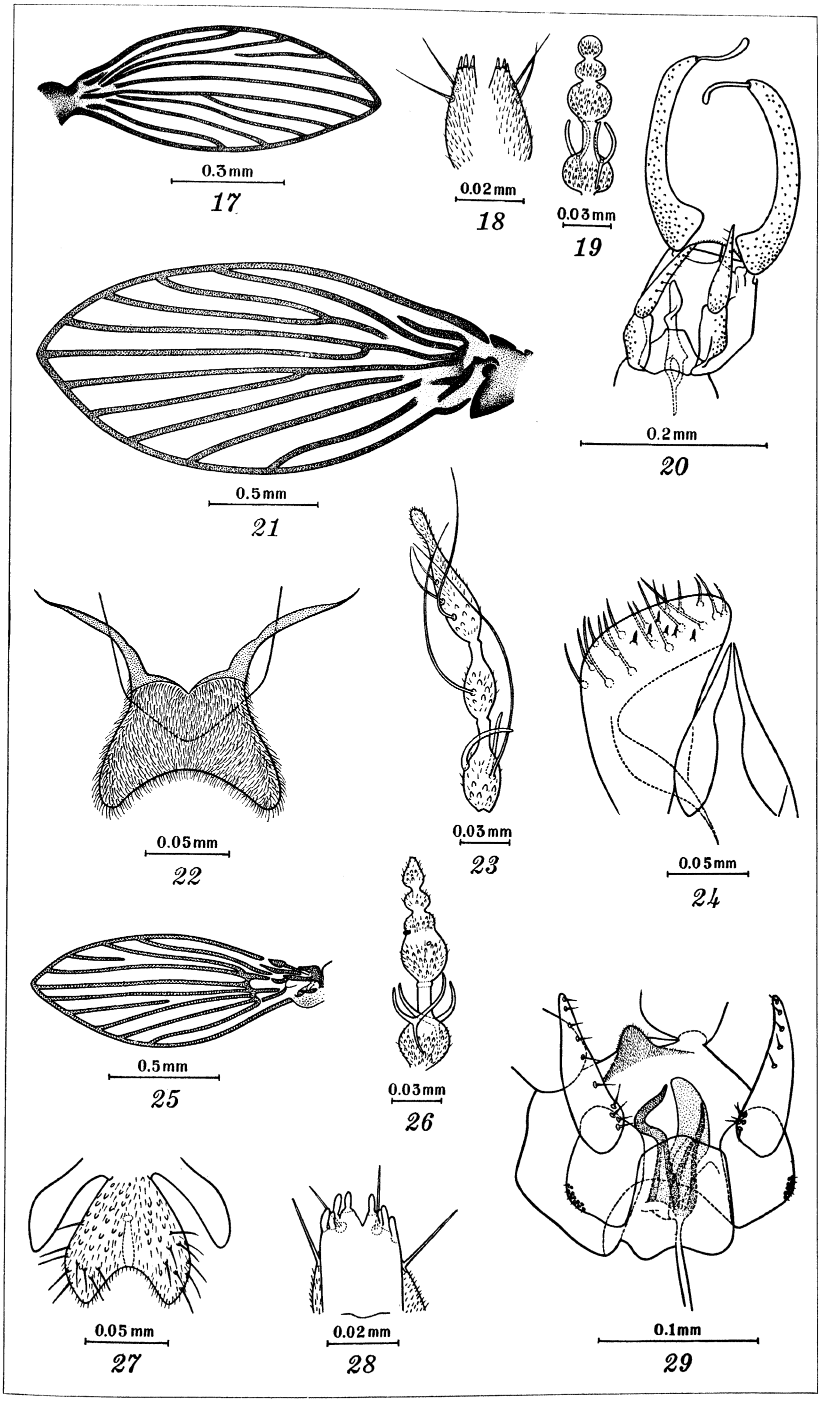
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PLATE 2.

LATE EIGHTEENTH-CENTURY KILN-REJECT JARS EXCAVATED AT THE SAN JUAN DE DIOS HOSPITAL FOUNDATION

By GENEROSO S. MACEDA

Of the National Museum Division, Bureau of Science, Manila

TWO PLATES

INTRODUCTION

Nearly all excavations made in Manila during the last four or five years for the layouts of tall-building foundations have yielded various specimens of archæologic interest. Objects of this nature that have not, or only partly, lost their originality are interesting to archæologists. It is one of these types of material, locally known as *tapayan* (tinaja in Spanish), that is reported in this paper. These tapayans were manufactured in a local kiln and were intended to contain water, vinegar, and other liquids.

It was only during the Spanish régime that the use of kilns and other improvements in pottery making were introduced in the Islands in order to meet the growing demand of the natives.

> The use of kilns and some improvements over the primitive methods of making pottery seem to have been introduced under the Spanish régime in order to meet the demands of household articles not found in use by the natives and to supply earthernware required in certain industries. The use of kilns permitted a better burning of the common red ware and they produced a sufficiently high temperature to semivitrify the product.(1)

Of course, there were already methods employed by the natives, but they were primitive ones, and the output was crude and only for home use.

Other places where collections of numerous Chinese, Siamese, and European porcelain pieces, native pottery, and human bones have been made are the Post Office site, the Metropolitan Theater site, the Ideal Theater site, the Plaza Moraga site, the Heacock Building site, and the Great Eastern Hotel site. The specimens are now in the collections of Prof. H. O. Beyer, of the University of the Philippines, and in the Bureau of Science; while Dr. J. P.

Bantug, of the Bureau of Health, and several other collectors have fair-sized collections from specific places.

THE PRESENT SITE

The jars were excavated at the site of the rear portion of the San Juan de Dios Hospital building, bordering Legaspi and San Francisco Streets. These jars were inverted in rows beneath a layer of earth and débris 1 meter thick, and practically covered an area of approximately 150 square meters.

JARS AS KILN REJECTS

The jars found were rejects with cracks on the sides and some with deformed shapes due either to improper heating or overcrowding in the kiln. Such jars cannot be utilized as containers. These jars probably were the waste products of one of the kilns owned by the religious orders in San Pedro Makati, Rizal Province, Luzon, from which this religious hospital obtained the rejects through donation.

. . . the religious orders possess the following estates: . . ., San Pedro Macati (where they have their earthenware factory, from which they make annually thirty thousand pesos fuertes net profit).(2)

DESCRIPTION OF THE JARS

The original color and luster have almost been preserved. The jars are heavy and of hard body. The shape is like that of the Chinese Sung type jars. The diameter is small, while the color is dark reddish brown and very similar to that of the ordinary tapayan in the Manila markets. The jars were not originally broken due to pressure of the ground floor (Plate 1), but were intentionally cracked by laborers in the belief that they contained hidden treasures.

USES OF THE JARS IN RELATION TO BUILDING CONSTRUCTION

The practical uses of the jars in connection with building construction may be mentioned as follows: The jars were laid in rows to support the basement floor of the hospital building; they took the place of the tremendous amount of earth that otherwise would have been needed to raise the elevation of the ground floor; and they were placed in such a manner in order to lessen the capability of the ground to hold water. The third use is rather an ingenious way of constructing floor tiles. The water that was occasionally left by the esteros during high tide

in those days easily seeps through this construction, which is porous on account of the spaces between and inside the jars.

POSSIBLE DATING OF THE JARS

The determination of the date of the manufacture of these jars depends on two factors; namely, the history of the hospital and that of the kilns where the jars were made.

We may first attempt to determine the date when the Hospital de San Juan de Dios building was constructed. This will give us the nearest age of the jars.

By virtue of a royal decree August 17, 1865, the Archbishop and the Governor-General transferred the management of the said hospital to a Board of Directors composed of *Excmo. Sr. Regente de la Real Audencia, presidente; Don* Tomas Balbas y Castro, *consejero de Administración, tesorero; Don* Mariano Tuason, *Don* Francisco de Paula Cembrano, *Don* Joaquin Pardo de Tavera, *consejeros de Administración;* y *Don* Manuel Asensi, *ponente de la Sección de lo Contencioso del mismo Consejo,* y *Don* Casimiro Cortazar, *jefe de Session del Gobierno Superior Civil.* This board of directors held a *Bazar de Caridad* in 1867 and out of this they made a net profit of 29,652.11 dollars. November 18, 1867, the *Excmo. Sr. Gobernador General Don* Jose de la Gandara signed the act of construction and laid the cornerstone of the recently demolished (rear portion only) San Juan de Dios Hospital building. The following day, November 19, 1867, the construction began.(3)

This date does not furnish us the exact age of the jars, but since these jars were used as filling material of the ground floor of the building it can be safely asserted that the age of these jars is not less than 68 years. However, these jars were not manufactured intentionally for filling purposes, but they were kiln wastes, and became such presumably some years before the hospital building was constructed. Hence, these jars are obviously older than the present Hospital de San Juan de Dios building.

REFERENCES

1. ADAMS, GEORGE I., and WALLACE E. PRATT. Philippine pottery. Philip. Journ. Sci. § A **5** (1910) 143–44.
2. PARDO DE TAVERA, T. H., in Blair and Robertson's Philippine Islands 1493–1898 **50** (1907) 154.
3. GINER, GREGORIO SANCHEZ. Memoria Historico-Administrativa del Hospital de San Juan de Dios (1897) 17–19.

ILLUSTRATIONS

[Photographed by Dr. C. S. Angbengco and Mr. G. Panlillo, of the Bureau of Science.]

PLATE 1

FIG. 1. The excavated foundation of the San Juan de Dios Hospital building showing the kiln-reject jars used as partial fillers.

2. Another portion of the excavated foundation of the same hospital showing the cracked jars, which were intentionally broken by the laborers in search for treasure.

PLATE 2

FIG. 1. Four representative types of the kiln-reject jars.

a. Greatest diameter, $15\frac{7}{8}$ inches; height, $21\frac{7}{8}$.

b. Greatest diameter, $16\frac{1}{2}$ inches; height, $22\frac{1}{2}$.

c. Greatest diameter, $17\frac{1}{8}$ inches; height, $24\frac{3}{4}$.

d. Greatest diameter, $18\frac{1}{4}$ inches; height, $21\frac{1}{4}$.

2. Interior view of one of the kilns in San Pedro Makati, Rizal Province, Luzon, introduced by the Chinese during the Spanish regime. The proprietor of the kiln is Mr. Justino Jimenez, of the same town.

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PLATE 1.

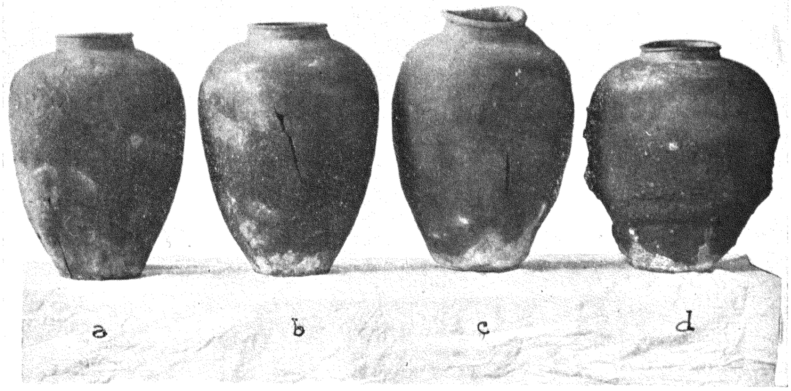

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PLATE 2.

BOOKS

Acknowledgment of all books received by the Philippine Journal of Science will be made in this column, from which a selection will be made for review.

RECEIVED

American association of cereal chemists. Committee on methods of analysis. Cereal laboratory methods with reference tables, comp. by Committee on methods of analysis. 3d ed. completely rev. Omaha, Nebraska, American association of cereal chemists, 1935. viii, 204 pp. illus.

American society for testing materials. Proceedings. 38th, 1935, pts. I–II, Philadelphia, Pa., American society for testing materials, 1935. Illus., fold. tables, diagrs. Price, $8.80.

BARNARD, W. G. The technique of a post-mortem examination. London, London county council, 1935. Cover title, 7 pp. Price, $0.25.

BELLER, SAMUEL. Coleoptera of Washington: Chrysomelidae, by Samuel Beller and Melville H. Hatch. Seattle, Washington, University of Washington press, 1932. 76 pp. plate. (Washington University. Publications in biology, 1932, vol. 1, No. 2, pp. 65–144.) Price, $0.50.

BESSEY, E. A. A text-book of mycology. Philadelphia, P. Blakiston's son & co. [c. 1935]. xv, 495 pp. illus. ports.

FICHERA, G. Chemioterapia del cancro. Milano, U. Hoepli, 1934. 213 pp. tables, plates. Price, $2.50.

GIBBS, C. S. A guide to sexing chicks. N. Y., Orange Judd pub. co., 1935. 63 pp. illus. Price, $1.25.

HATCH, M. H. Coleoptera of Washington: Silphidae, by Melville H. Hatch and William Reuter, jr. Seattle, Washington, University of Washington press, 1934. 13 pp. (Washington University. Publications in biology, 1934, vol. 1, No. 3, pp. 147–162.) Price, $0.15.

HOTSON, J. W. Key to the rusts of the Pacific northwest. Seattle, Washington, Univ. of Washington press, 1934. (Washington University. Publications in biology, 1934, vol. 3.) 103 pp. illus. Price, $1.50.

HUBBS, C. L. Description of two new American species referable to the rockfish genus Sebastodes, with notes on related species, by Carl L. Hubbs and Leonard P. Schultz. Seattle, Washington, University of Washington press, 1933. (Washington University. Publications in biology, 1933, vol. 2, No. 2, pp. 15–44.) 42 pp. table, plates. Price, $0.25.

JAFFE, BERNARD. New world of chemistry. N. Y., Silver Burett and Co. [c. 1935] xii, 566 pp. xxx, front. illus., port., diagrs. Price, $1.80.

James Johnstone memorial volume. Liverpool, London, University press, 1934. x, 348 pp. front. illus. tables, fold. diagrs. maps. Price, $5.25.

JOHNSON, M. W. Seasonal distribution of plankton at Friday Harbor, Washington. Seattle, Washington, Univ. of Washington press, 1932.

(Washington University. Publications in oceanography, 1932, vol. 1, No. 1, pp. 1–38.) 38 pp. tables, diagrs. Price, $0.35.

JOHNSON, M. W. The seasonal settlement of shipworms, barnacles, and other wharf-pile organisms at Friday Harbor, Washington, by Martin W. Johnson and Robert C. Miller. Seattle, Washington, Univ. of Washington press, 1935. (Washington University. Publications in oceanography, 1935, vol. 2, No. 1, pp. 1–18.) 18 pp. tables, diagrs. Price, $0.20.

KENDEIGH, S. C. The rôle of environment in the life of birds. 1934. 117 pp. maps. tables, diagrs.

PHIFER, L. D. Phytoplankton of East Sound, Washington, February to November, 1932. Seattle, Washington, University of Washington press, 1934. (Washington University. Publications in oceanography, 1934, vol. 1, No. 4, pp. 97–110.) 12 pp. tables, diagrs. Price, $0.15.

PHIFER, L. D. Vertical distribution of diatoms in the Strait of Juan de Fuca. Seattle, Washington, University of Washington press, 1934. (Washington University. Publications in oceanography, 1934, vol. 1, No. 3, pp. 83–96.) 12 pp. tables, diagrs. Price, $0.15.

SEWART, DOROTHY. Comp. The medical cookery book, containing three hundred recipes for the use of invalids, convalescents and children, comp. by Dorothy Sewart, with an introduction by J. W. McNee. Bristol, J. Wright & sons, 1935. 136 pp. Price, $1.25.

SHOEMAKER, J. S. Small-fruit culture; a text for instruction and reference work and a guide for field practice. Philadelphia, P. Blakiston's son & Co. [c. 1934]. xv, 434 pp. illus., tables. Price, $3.50.

SLAGLE, E. C. Games and field day programs, comp. and ed. by Eleanor Clarke Slagle. Utica, N. Y., State hospital press [c. 1933]. vi, 134 pp. illus.

WORLEY, L. G. The spiders of Washington; with special reference to those of the San Juan Islands. Seattle, Washington, University of Washington press, 1932. (Washington University. Publications in biology, 1932, vol. 1, No. 1, pp. 1–63.) 63 pp. Price, $0.50.

REVIEWS

Practical Handbook on Electro-Plating. W. Canning & Co., Ltd., Birmingham, London, 12th ed., 1934. 344 pp. Price, $1.

This book gives a detailed description of the operations carried on in an electroplating shop. It is profusely illustrated with drawings and photographs of numerous electroplating installations indicating the arrangement of the apparatus and accessories used. The contents of the book are divided into four sections. Section 1 deals with the grinding and polishing of the object to be plated; section 2, with cleaning and dipping operations; section 3, with electroplating; section 4, with bronzing, lacquering, and enameling.

The detailed descriptions in the text together with the photographic illustrations of the methods of carrying out the various

operations give the ordinary reader complete information on the subject.—F. D. R.

Southeast of Zamboanga. By Vic Hurley. E. P. Dutton & Co., Inc., New York, 1935. 237 pp. Illustrated. Price, $3.

This is a book of travel or forest adventure. It deals with two Americans who, after graduation from college, went to southeastern Mindanao to make a fortune by raising coconuts. During their stay in that part of Mindanao they encountered great hardships and became sick for they were not accustomed to the climate.

The book covers a period of one year in the interior of Mindanao and deals with the economic and social life of the Moros and other pagan groups. It portrays the economic and social life of the people at close range. It is exceedingly interesting and inspires an anthropologist to make further observations on the Mohammedan and pagan peoples in that part of Mindanao where their economic and social life is least known.—R. E. G.

The Elements of a National Mineral Policy. Prepared by The Mineral Inquiry: C. K. Leith, Chairman. American Institute of Mining and Metallurgical Engineers, New York, 1933. 162 pp.

This book gives a brief but comprehensive discussion of a few selected topics related to the mineral industry and the place of that industry in the newly evolved philosophy of economic nationalism and the problem of national defense. There is a great divergence of opinion among several authorities as to the national policy a nation should pursue in order to attain economic self-sufficiency and national security. It may be noted, however, that there is a tendency to favor the coördination of all industries with the view of producing the best economic results for the nation as a whole as against the present catch-as-catch-can practice; that is, everybody for himself with private gain as the supreme aim of his endeavors.

While the book propounds no definite policy with regard to minerals, it is nevertheless very enlightening and should be valuable to students of economics, especially to those who are at the helm of the Commonwealth of the Philippines and are called upon to direct the destiny of our newly-born nation.—Q. A. A.

Biology for the Public School Administrator. By Frederick L. Fitzpatrick. Teachers College, Columbia University, New York, 1st ed., 1934. 87 pp.

This book is intended primarily for administrators who have to deal with the framing of courses in general biology for high

schools. The subject, however, is so presented as to be useful for student teachers, teachers, critic teachers, and supervising teachers in high-school biology. Concisely written, it gives a historical sketch of the development of the high-school course in general biology and sets forth the necessity of correlating the course with everyday experiences. It enumerates the qualifications, the training, and the experience a biology teacher should have. It also gives the various teaching procedures in general biology as well as the necessary supplies and equipment needed for the successful teaching of biology. Chapter II of the text is an outline of the course in general biology, which is so complete, comprehensive, and inclusive that it could be very well adopted in the Philippines. The list of references and other sources of information contained in the last chapter is a good aid to teachers and investigators in the preparation of lessons or manuscripts.—H. A. R.

Population Theories and their Application, with Special Interest to Japan. By E. F. Penrose. California Food Research Institute, Stanford University, 1934. 347 pp. Price, $3.50.

Population Theories and their Application is an offshoot of some studies undertaken by the author under the Food Research Institute established at Stanford University, California.

It deals with the economic situation which has developed in modern times with the passing of regional self-sufficiency and the large increase in the population of eastern and southeastern Asia.

The rapid growth of population has not prevented changes which have transformed the material conditions of life in modern times.

Inventions, improvements in technic, expansion in productive capacity, and the exercise of more individual control over the birth rate have made it increasingly improbable that the world as a whole will ever be placed in the situation envisaged in the Malthusian theory.

The human race cannot in any case be distributed over the world in such a way that each group has the same advantages as all others with respect to the possession of natural resources. Inequalities can to a certain extent be offset by movements of population, capital, and goods.

It is an up-to-date book because it deals with the present economic conditions of life particularly in eastern and southeastern Asia.—R. E. G.

Sex and Temperament; In Three Primitive Societies. By Margaret Mead. W. Morrow and Company, New York, 1935. 335 pp. Price, $3.

The author of this book of descriptive anthropology is assistant curator of ethnology in the American Museum of Natural History. The materials accumulated in the book are the result of two expeditions to New Guinea in 1931–1933.

The book deals with the social life of the three primitive people of New Guinea—the mountain-dwelling Arapesh, the river-dwelling Mundugumor, and the lake-dwelling Tchambuli.

By studying these three types of primitive peoples the author is led to suggest that the behavior which our society believes is determined by sex, may be socially determined, and that the most significant differences are those between different human beings and not between the sexes.

The book contains fresh and abundant data concerning the peculiar social life of the three primitive peoples mentioned, into the social life of whom the author displays a keen insight.

—R. E. G.

Manual of Land and Fresh-Water Vertebrate Animals of the United States (exclusive of Birds). By Henry S. Pratt. P. Blakiston's Son & Co., Inc., Philadelphia, 2d ed., 1935. 416 pp. Price, $6.

This book is a compilation of the works of various authors on the identification, habitat, and geographical limits of species, subspecies of vertebrate animals, exclusive of birds, of the whole United States between the Canadian and Mexican borders. The second edition embodies numerous changes in the nomenclature of the vertebrate animals of the United States and defines more precisely their known ranges of distribution. This book is important to students of zoölogy, especially to those taking up work in animal geography. Although the species of animals treated are non-Philippine, this book should interest Philippine students of comparative anatomy and geographical distribution of vertebrates as it gives much useful information on the characters used in the identification of fishes, amphibians, reptiles, and mammals. The book is fortunately provided with comprehensive keys for the determination of the higher groups.

—H. A. R.

Handbook of Industrial Fabrics. By George B. Haven. Wellington Sears Co., New York City, 1934. 538 pp. Price, $2.

One finds in this authoritative work by the head of the textile research department of the Massachusetts Institute of Techno-

logy an abundance of information and data on industrial fabrics, that, having been hitherto in more or less scattered form, have been brought together and condensed for the convenience of textile chemists, engineers, designers, testing laboratories, and students. The book is presented in a concise manner and is comprehensive enough to include fibers and fabrics of cotton, cotton yarns, uses of fabrics and their properties, laboratory design and practice, and specifications and test methods. It is primarily intended as a handbook for the technical worker, but will be equally useful as a reference volume for others.—J. C. E.

Modern Method of Birth Control. By Thurston S. Welton. W. J. Black, Inc., New York City, 1935. 168 pp. Price, $3.

Doctor Welton has gathered together in more accessible and companionable form the results of long years of investigation conducted by authorities on drugless birth control. The separate labors of Doctor Ogino, of Japan, and Doctor Knaus, of Australia, represent the most authoritative efforts ever pursued by scientists along this line and they are here conjoined for the benefit of prolific householders.

The book addresses especially itself to dogmatic and faithful members of the Roman Catholic faith who will find a relief from excess biological procreation in a manner sanctioned by the Holy Father at Rome, without undergoing the strain of denying the faithful the essential fulfillment of the natural biological urge. This book advocates, therefore, the practice of rhythm.

The studies of the above-cited authorities point out that within the mense cycle of women there are two fallow, or sterile, periods and between these two periods is the fertile one, representing only a week of virtual fasting. It could be made less by three days if women have no aversion to douching after cohabitation if such a thing happen just before the advent of the real fertile period.—M. G. C.

The Marine Plankton with Special Reference to Investigations Made at Port Erin, Isle of Man, during 1907–1914. By James Johnstone, Andrew Scott, and H. C. Chadwick. The University Press of Liverpool, Ltd., London, 3d reprint, 1934. 194 pp. Price, $3.25.

This text, written by outstanding English authorities on oceanography and marine biology, is one of the best books put out on the subject. The contents are the results of intensive and extensive plankton studies for a great number of years. In a very readable and clear form, the authors have set forth the

categories of life in the sea, the various plankton types, the distribution of the plankton, and the relation between organic production and the plankton. In an appendix the various types of plankton nets and methods of collection, as well as the methods of the estimation of the catch, are accurately described. The book is practical as well as theoretical. Students requiring the identification of their plankton can readily use its many plates and descriptions for reference. Once the organisms are identified the student gets much information from the many tables and the text as to abundance and seasonal occurrence. The more philosophic biologist can follow Professor Johnstone's inquiry into the causes and effects of marine phenomena. This book is indispensable for students as well as researchers in marine plankton.—H. A. R.

American Scientists. By C. J. Hylander. Macmillan Company, New York, 1935. 186 pp. Price, $2.

Narratives of the lives of great men usually tend to have an inspiring influence for, as Longfellow said:

Lives of great men all remind us
We can make our lives sublime,
And, departing, leave behind us
Footprints on the sands of time.

Books of this kind record the great things men have done, but many of them do not state exactly how these men got their start on the road to fame. This book is different in this respect. For instance, it states how Roy Chapman Andrews began his scientific career by washing floors and receiving no salary for it. This is quite a contrast to many of our present-day graduates who are more concerned with the salary they can get than with their work as a career.

American Scientists is a little book that is easy to read and is very interesting not only for scientists but also for the layman.—A. P. W.

Helminth Parasites of the Domesticated Animals in India. By G. D. Bhalerao. (The Imperial Council of Agricultural Research. Scientific Monograph No. 6.) Manager of Publications, Delhi, 1935. 365 pp. 13s. 3d.

In view of the economic importance of worm parasites in relation to the health of domesticated animals in India, the author deplores the lack of reference facilities for the correct determination of helminths and the inconvenience of sending

collections to foreign specialists. The present volume has been prepared to fill this gap and serves at the same time as a systematic check list of the helminth parasites reported from Indian domesticated animals. It should be a useful reference to workers, not only in India but in other countries as well.—M. T.

Sedgwick's Principles of Sanitary Science and Public Health. By Samuel C. Prescott and Murray P. Horwood. The Macmillan Company, New York, rewritten & enlarged, 1935. 654 pp. Price, $4.25.

This book gives important information about health and its preservation. It begins with the relation of the intrinsic mechanism of the human machinery to the innumerable extrinsic factors of the human body. The authors formulate fundamental facts for the preservation of the individual and the community. They also tell how to conquer the vast enemies of human life in particular and the community in general. Therefore, this book is recommended not only to students and health practitioners, but to all those interested in sanitation and public health.—M. B.

Cereal Laboratory Methods with Reference Tables. Compiled by The Committee on Methods of Analysis, American Association of Cereal Chemists. The Association, Omaha, Nebraska, 3d ed., 1935. 204 pp.

This is the revised third edition of Cereal Laboratory Methods. It contains a number of procedures not given in the Methods of Analysis of the Association of Official Agricultural Chemists. The analytical procedures are written up plainly and concisely. This book is a valuable addition to the literature on cereal chemistry. It should also serve as an important reference book for general analytical work.—A. J. H.

A. S. T. M. Standards on Rubber Products. Prepared by Committee D-11 on Rubber Products. A. S. T. M., Philadelphia, Penn., 1935. 204 pp.

This compilation is in a convenient form for laboratory use and a valuable one for reference purposes. The specifications include detailed procedures for physical and chemical examinations of such products as cotton rubber-lined fire hose, rubber pump valves, friction tape, rubber insulating tape, rubber gloves, rubber matting, rubber insulating blankets, and insulating wire and cable.—R. H. A.

Modern Motherhood; A Book of Information on Complete Maternity Care: Prenatal-Delivery-Aftercare. By C. E. Heaton. Farrar & Rinehart, Inc., New York, 1935. 271 pp. Price, $2.

This book gives to expectant parents sound information on the nature of pregnancy and childbirth and though tactfully discouraging self-doctoring, gives full information on maternity care. In easy, comprehensible language and breathing throughout a wise conservatism supplemented by opportune quotations, the author discusses the subject of motherhood from the strictly biological to the psychological, economical, and sociological aspects. Not only prospective parents but other intelligent readers of both sexes should benefit by a careful perusal of this book.

—A. V. C.

Le Chauffage par les Combustibles Liquides. Par A. Guillermic. Librairie Polytechnique Ch. Beranger, Paris, 1935. 394 pp. 338 figs.

This book gives a description of the various fuel oils generally used in the industries. It discusses various types of oil burners, illustrated by appropriate drawings. It includes those that are suitable for operation with low and high air pressure, steam, and atomization by mechanical means. Perhaps the most important feature of the book is the drawings of actual installations as used in the industries and the comparative results obtained on the use of fuel oil and coal for heating and power.

—F. D. R.

Child Nutrition on a Low Priced Diet. By Mary S. Rose and Gertrude M. Borgeson. (Child Development Monographs, no. 17.) Teachers College, Columbia University, New York City, 1935. 109 pp. Price, $1.50.

This monograph gives instructive information on the nutrition of children. It is very practical, since the nutritious diets suggested are low in price. The discussions of the various topics such as diet, physical development, etc., are given in a popular style and hence the monograph is very appropriate for the layman.—A. J. H.

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One hundred separates of each paper published in the Journal are furnished to the author without charge. Additional copies may be had at the author's expense if ordered when the manuscript is submitted for publication.

The Journal is issued twelve times a year. The subscription price is 5 dollars United States currency per year. Single numbers, 50 cents each.

Subscriptions may be sent to the Business Manager, Philippine Journal of Science, Bureau of Science, post-office box 774, or to the Publications Division, Department of Agriculture and Commerce, post-office box 302, Manila, P. I., or to any of the agents listed below.

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The Macmillan Company, 60 Fifth Avenue, New York, N. Y.
Martinus Nijhoff, Lange Voorhout 9, The Hague, Holland.
G. E. Stechert & Co., 31–33 East 10th Street, New York, N. Y.
The Maruzen Co., Ltd., 6 Nihonbashi, Tori-Nichome, Tokyo, Japan.

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